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ABSTRACT

Designed for instructors with little or no map and compass experience, the self-contained manual contains background information, lesson plans, student handouts, and references for teaching the basic skills of map and compass use to junior high and senior high school students and youth groups. An introductory section briefly discusses the importance of map and compass skills, establishes unit goals and objectives, gives a brief history of maps and compasses, and addresses the ethical concerns and responsibilities of the map and compass user. In addition, the section introduces map information, latitude, longitude, scale, map symbols, magnetic compasses, finding directions with a compass, using a map and compass together, and resectioning. The manual includes seven 50-minute or longer lesson plans which cover understanding map symbols, reading compasses and topographic maps, setting compass bearings, using a map and compass together to plan trips, locating positions on maps from compass readings, and Orienteering. Each lesson plan includes teaching method, time, purpose, instructional aids, facilities required, and an outline. The manual, illustrated with black and white maps and drawings, also contains nine additional learning activities, a glossary, a bibliography, and appendices which include an instructional unit on topographic maps, reproducible student handouts, and additional learning activities. (SB)

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MAP AND COMPASS

OUTDOOR LIVING SKILLS SERIES

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A PROGRAM OF THE MISSOURI DEPARTMENT OF CONSERVATION

OUTDOOR SKILLS EDUCATION MODULES

Missouri's natural resources belong to all its citizens. More and more people are going outdoors to hunt, fish, boat, hike, camp, explore, and learn about nature. The skills they use in the outdoors can have a direct effect on resources. That's why it is important to educate youth and adults in how to use the outdoors wisely and responsibly through schools, community groups, and agencies.

The Outdoor Skills Education Unit of the Department of Conservation, in cooperation with the Department of Elementary and Secondary Education, is developing educational programs to teach Missourians how to use wisely and skillfully the state's many resources for outdoor recreation. The materials, presented as modules, can be used individually or combined in a series by schools, camps, clubs, scouting groups, and other youth or adult organizations. Topics include the shooting sports, casting and angling, trapping, archery, backpacking, camping, aquatics, map and compass, and other skill areas.

Each module is a self-contained unit that includes information on the subject, lesson plans, activities, class exercises, tests, suggested visual aids, and references. Experienced instructors who have taught the subjects and successfully used the activities have written the modules.

For additional information on conservation and outdoor education programs, write the Education Section, Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO 65102.

INSTRUCTOR MANUAL

MAP AND COMPASS

OUTDOOR LIVING SKILLS SERIES

MISSOURI DEPARTMENT OF CONSERVATION
EDUCATION SECTION

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Gail S. Ludwig is Assistant Professor of Geography and Director of the Geography Extension Program at the University of Missouri-Columbia. As part of her extension program, she runs several outdoor environmental education workshops each year. Prior to her university position, she taught social studies at the junior high level in Denver, Colorado.

Gail was awarded a Fulbright Exchange Scholarship in 1972 and taught geography and environmental education in England. While there, she became an avid rock climber and first competed in Orienteering® activities. Her enthusiasm for Orienteering prompted her to integrate map and compass activities into her classroom. She has written *Geography and Environmental Education,* a compilation of these activities which has been used as a textbook in environmental education classes.

An avid outdoor person, Gail has backpacked throughout the Rocky Mountains, Grand Canyon, and Alaska. She attended the Colorado Outward Bound School and has organized workshops in remote areas of this country and abroad.

Gail received a bachelor of science degree in education from Central Michigan University and her master of arts and doctor of arts degrees in geography and outdoor environmental education from the University of Northern Colorado. She and her husband, Philip Jones, and daughter, Rebecca, live in Columbia, Missouri.

How to use this module

This module has been produced for those who work with youth. The material is directed toward the secondary school teacher but may be adapted for use by youth group leaders. A variety of information and activities is included to make the module useful to as many groups as possible. It may be used individually or combined with other outdoor skills modules.

Subject information in this module is designed for instructors with little or no experience with map and compass. Instructors who have *no* experience should be sure to practice lessons and activities before teaching them.

Map and compass skills are useful for many outdoor activities.

The Map and Compass module contains:

Introductory Information—The importance of map and compass skills in outdoor and everyday activities is discussed. Goals and objectives approved by the Missouri Department of Elementary and Secondary Education are established.

Ethics—This module addresses some of the ethical concerns and responsibilities of individuals when they are using a map and compass in the outdoors.

Note: Orienteering® is a registered trademark owned by Silva, a division of Johnson Camping, Inc.

Subject Information—This section provides background information necessary to teach students the skills of map and compass use. The introductory section assumes the instructor has little or no previous experience with map and compass.

Lesson Plans—Seven lesson plans using field-tested techniques are provided. Lesson plans include listings of approximate time required, necessary materials, and supplementary activities.

Student Handouts—Information sheets for student use are included in the appendix. These handouts are keyed to individual lessons and may be reproduced for students.

Suggested Examination—Appendix 8 is designed as a culminating activity that may be used to determine if students have mastered the objectives of the course.

Glossary and Bibliography—These are provided as additional information and reference.

Outdoor Skills Education Specialists are assigned to seven regions throughout the state plus the Lake City Training Center. They will assist you in obtaining materials and scheduling equipment and films that are available from the Department of Conservation. Check the last page of this module for names, addresses, and regions.

Review Committee

The material in this module has been reviewed by the education section administration, outdoor skills education specialists, and a review committee comprised of the following people:

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Please help us evaluate the effectiveness and use of our materials by completing the following questionnaire and mailing it to the Missouri Department of Conservation, Outdoor Skills Education, P.O. Box 180, Jefferson City, MO 65102.

How did you obtain a copy of this module? ______________________________

Have you used this material? Why or Why not? ______________________________

Your position ______________________________

Age group you teach ______________________________

CONTENT AND FORMAT

Were you given enough information to teach this course?

Enough _______ Not Enough _______ Too Much _______

Comments: ______________________________

____

Was material presented in a manner easy for you to use?

Yes _______ No _______

Comments: ______________________________

____

What information would you add or subtract? ______________________________

____

LESSON PLANS AND ACTIVITIES

Did you use the lesson plans? All of them _____ Some of them _____ None of them _____

Were the time periods allowed for activities adequate? Adequate ____ Too much time ____ Not enough time ____

Comments: ______________________________

____

What additional activities would you include? ______________________________

Which activities did students most enjoy? ______________________________

What suggestions do you have for future modules? ______________________________

What topics would you like to see covered? ______________________________

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Topic Outline

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I. Goal of module
II. Purpose
III. Content
IV. Objectives
V. Brief history
    A. Maps
    B. Compasses

Ethics

Responsibilities in outdoor use

Importance of Map and Compass

I. Use in daily activities
II. Special uses

Maps

I. Definition
II. Types of maps
III. Topographic maps
    A. Latitude/Longitude
    B. Scale
        1. Ratio map scale
        2. Bar scale
    C. Symbols
    D. Contour lines

Compasses

I. Magnetic compasses
II. Basic principle of a compass
III. Parts of an Orienteering compass
    A. Magnetic needle
    B. Revolving compass housing
    C. Transparent base plate
IV. Finding direction using a compass
V. Finding direction from a map

Using Map and Compass Together

I. Declination
    A. Compass bearing
    B. True bearing
II. Following a compass course taken from a map
III. Resectioning
    A. Without a compass
    B. With a compass

Orienteering

I. Recreational map and compass reading
II. Competitive Orienteering

Introduction

Goal of the module

To teach students the basic skills of map and compass use so these skills can be applied when using our natural resources.

Purpose of the module

Direction-finding and the skills of map and compass use are valuable in everyday life and many outdoor activities. For those who hike, hunt, fish, canoe, or backpack into remote areas, map and compass skills are as necessary as basic first aid.

Learning map and compass skills is important to help you avoid or expediently handle wilderness emergencies. Beyond safety, knowing map and compass skills can make other outdoor activities more fun.

This is a basic skills unit aimed at teaching how to use a map and compass. It is not designed to teach the competitive sport of Orienteering. Learning to be expert at Orienteering requires advanced study and training. Appropriate references are listed in the bibliography.

Content of the module

This module is written for use with junior and senior high school students. The lessons are organized into seven presentations which include activities. Most lessons may be done in a 50-minute period taught in the classroom, school yard, or elsewhere. All lessons are "hands-on" and should involve as much student participation as possible.

Lessons deal with specific skills and should be followed in sequence, if possible. Topics include understanding map symbols, reading topographic maps, reading a compass, how to set a compass bearing from a route drawn on a map, how to use map and compass to plan outdoor trips, and how to locate positions on a map from compass readings taken from objects on the landscape. In addition to being good preparation for many outdoor activities, map and compass skills can be adapted easily for use in teaching elementary geometry, especially angular measurement.

Map and compass skills are useful in teaching geometry.

Objectives

Upon completion of this module, the student should be able to do the following:

1. Recognize and identify common map symbols used on topographic maps.
2. Interpret contour features on a topographic map.
3. Determine actual distances from map measurements.
4. Determine the compass bearing for a route marked on a topographic map.
5. Explain declination and its significance in map and compass use.
6. Follow a marked map course with a compass, making corrections for declination.
7. Determine location on a topographic map using bearings taken from objects in the field.

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Brief history

MAPS

Maps have been used for centuries to communicate and describe our environment. The origin of maps is lost in history. The earliest known maps were drawn on clay tablets more than 4,000 years ago. The map as a tool, however, probably predates even this period.

It is easy to imagine early man, in the light of a campfire, tracing lines in the soft earth. The lines may have shown outstanding features of the landscape, routes to water, game trails, and the location of neighboring tribes. From such simple beginnings, maps and mapmaking have risen to the level of an exact science. Today, mapmaking (called cartography) uses satellite images and aerial photographs to precisely locate natural and man-made features on the earth's surface.

COMPASSES

The beginnings of the compass are also uncertain. About 2500 B.C., some sage Chinese discovered that when lodestone was placed on a piece of wood floating in water, it always turned to the same direction. From this observation, the compass needle was invented—a strip of magnetized steel balanced on a pivot, free to swing in any direction. The Greeks may also have known about lodestone's unique properties.

By 1000 A.D., seafarers were using a primitive magnetic compass to help them navigate and to check the wind direction at sea when there were no stars visible. A French crusader provided the first detailed written description of a magnetic compass in 1269. He wrote of a magnetized needle that rotated on a pivotal axis. It was placed in a box with a transparent cover and primarily used for navigation at sea.

Ethics

When using a map and compass, you should be considerate of the landscape and people. Always obtain permission before undertaking map and compass activities on private property. Respect landowners by leaving gates in whatever condition you found them. (Open, if found open; closed, if found closed.)

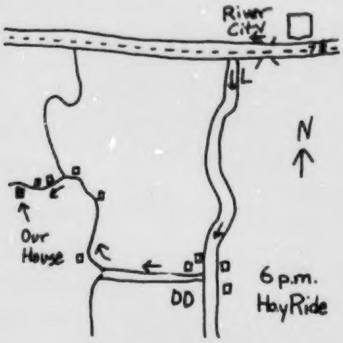
Avoid climbing fences whenever possible. If fence climbing cannot be avoided, take extreme care to avoid damaging fences. When following a compass course through woods or brushy terrain, don't break branches to clear a path. Also, when laying out Orienteering courses, avoid nailing markers into living trees. Markers attached to wooden stakes and set in the ground work best for most uses. Remove all markers at the end of the activity.

You should also be considerate of wildlife and be careful not to disturb their nesting sites. Spring and early summer are when most animals bear and rear their young. If you are going to use an area during this time of year, scout it carefully, then route groups around nesting areas.

By following these simple rules and using your own common sense, you can thoroughly enjoy the excitement of map and compass activities. You also ensure that those who come after you will enjoy themselves as you did.

Importance of Map and Compass

Use in daily activities



Map and compass skills are used every day by people from all walks of life. Vacation plans usually begin with a review of highway maps and maps provided by travel agencies. Simple sketch maps show the way to a friend's home, family reunion, or school picnic. Directions given by a service station attendant may begin with: "Go north two blocks, then turn right. Continue east until you reach..."

In addition to following directions and reading maps, most people have occasion to draw their own maps and give directions. The success of a backyard barbecue or a school field trip may rest upon how skillfully directions are given and taken.

Special uses

This lost hiker should have used a map and compass.

Map and compass skills are unique because they are useful and essential in a wide range of outdoor activities. Outdoor enthusiasts have a special need for such skills. Their activities take them away from familiar landmarks and the securities of civilization. Sportsmen travel with the terrain, not in a straight line, and can quickly become disoriented. Getting lost outdoors can range from an annoyance to a tragedy. All outdoor enthusiasts owe it to themselves and their families to be familiar with the skills of "staying found" through the use of a map and compass.

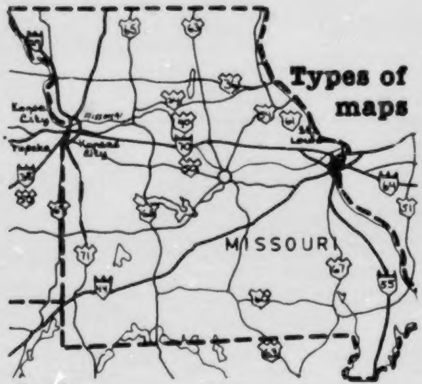
Besides safety, there are other uses for map and compass skills. Hunters and fishermen can use direction-finding and map reading skills to locate favorite hunting and fishing spots. Hikers and backpackers can use the skills for cross-country travel, away from marked trails. Many outdoor professions—forestry, engineering, surveying—depend on the ability to use maps and compasses accurately.

A map and compass function best when they are used together as a team. But first, it's best to learn to use each separately.

Maps

Definition of a map

What is a map? It's more than a sheet of paper with lines drawn on it. A map represents a portion of the surface of the earth as it would be viewed from a vertical perspective. This representation is reduced to a usable size.



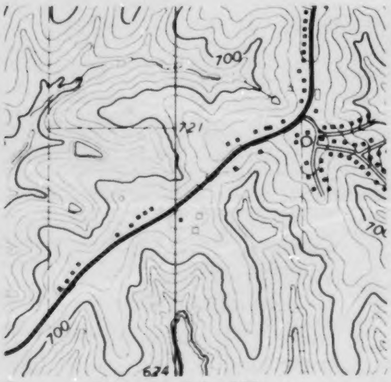
Road map

Types of maps

There are many kinds of maps. The most common is the road map showing transportation routes and cities. Soil maps tell what kinds of soils are found in an area. Geological maps show the structure of the earth's crust, types of rocks, and forms of life found as fossils in a given area. Land use maps show how a portion of the earth's surface is being used. Topographic maps show the physical and cultural characteristics of an area which includes: elevation; rivers, streams, and reservoirs; roads and hiking trails; cities and villages; and a multitude of other features.

Topographic maps

Note to instructors: Have topographic maps available for students to use.



Topographic map, 1:24,000

For general outdoor use, the United States Geological Survey (USGS) topographic maps are considered best (see bibliography). These maps come in several sizes and scales, but the one most often used is the 1:24,000 scale or 7.5 minute quadrangle map. (These terms will be explained shortly.)

Compare the features of a road map with those of a topographic map. Both are graphic representations of a portion of the earth's surface at a reduced scale. The road map plots position and distance of cities and roads, but it tells nothing about the terrain. The topographic map shows cultural features such as towns and highways too. But natural features also are included and, perhaps most important, contours which show the shape and elevation of the land.

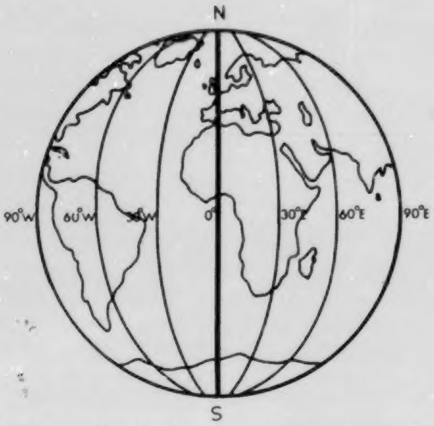
A topographic map contains more information than a road map, so you need more skill to read it. The first step is to study the map's margin.

Items printed in the map's margins are called descriptors. The map name appears in the top and bottom margin and is often determined by the main feature in the area covered. Words in parentheses in the margins are names for topographic maps of adjacent areas.

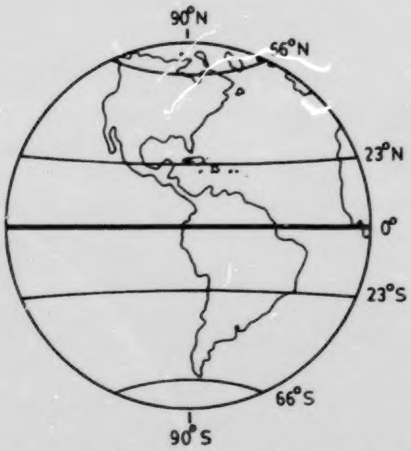
CYCLONE HOLLOW QUADRANGLE
MISSOURI
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 RICHWOODS 15' QUADRANGLE

Map descriptors

In order to locate places, features, or areas on a map, ancient mapmakers devised a system of lines—a grid that fits the earth. There are many different grid systems used by professional geographers and cartographers but by far the most common grid system used is latitude/longitude.



Lines of longitude, or meridians, measured in degrees.
0° = prime meridian



Lines of latitude, or parallels, measured in degrees.
0° = Equator

LATITUDE/LONGITUDE

The latitude/longitude grid system is one of several systems used on USGS topographic maps. Numbers in the margin, such as 38°22'30" indicate either the latitude or longitude of the area covered by the map. These numbers pinpoint the area's location on the globe.

Lines of longitude (also called meridians) run from the North Pole to the South Pole and completely circle the globe. The prime meridian which runs through Greenwich, England, is given a value of zero degrees. All other meridians are given a value based on their positions east or west of the prime meridian.

Longitude values on topographic maps are found along the top and bottom edges of the map. For the continental U.S. these values will range between approximately 70°W on the coast of Maine and 125°W on the west coast of California.

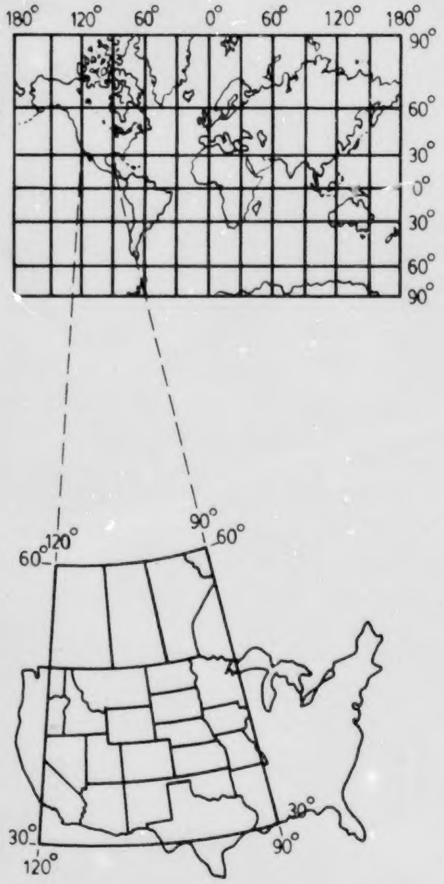
A series of horizontal lines that run in an east-west direction around the globe are called lines of latitude. The equator is identified as zero degrees. The North Pole is 90°N and the South Pole is 90°S. Lines of latitude are often called parallels because each line is equal distance from the other and are assigned values based on their position north or south of the Equator.

Latitude values on topographic maps are located along the sides of the map. The lower 48 states lie between 48°N latitude (Maine) and 26°N latitude (southern Texas).

The values assigned to lines of latitude and longitude are expressed in degrees of a circle and are further broken down into minutes and seconds. A degree has 60 minutes, and a minute has 60 seconds. Latitude lines range from zero degrees at the Equator to 90 degrees north or south at the respective poles. Longitude lines have values ranging from zero degrees at the prime meridian to 180 degrees at the International Date Line. Thus a latitude measurement of 37° 15'30"N appearing in a map margin would be read as "37 degrees, 15 minutes, 30 seconds, north latitude." A longitude value appearing in the upper or lower map margin of 92°15'W would be read as "92 degrees, 15 minutes, west longitude." You can pinpoint any location on earth by finding the point where the two coordinates, latitude and longitude, intersect.

Topographic maps are sometimes identified using the area of longitude covered by the map sheet. Thus a USGS "15 minute" topographic map covers 15 minutes of longitude or approximately 18 miles, while a "7.5 minute" topographic map covers approximately 7 miles.

Other descriptors are also contained in the map margins. Dates given at the bottom of the map indicate when the map was made and field-checked. These dates are important because new features may not be shown. A highway, lake, or subdivision may have appeared since the map was made and field-checked.



You can pinpoint any location by finding the point where latitude and longitude lines intersect.

During field-checking, surveyors may visit the area represented by the map. They will note the accuracy of map measurements and examine the area for any new features that may have appeared since the map was made. Most frequently, topographic maps are field-checked by taking an aerial photograph and examining it for changes or additions. For example, a river may be dammed to form a lake, a subdivision might be constructed in a meadow, or a hill might be leveled to make way for a new highway. These changes can be quickly and accurately identified by using aerial photography.

SCALE

When using maps it is essential to know how far it is from one location to another. If a secluded lake or reservoir is located on a map and you would like to hike into it to go fishing, you need to know if you will be walking 1 mile, 5 miles, or 50 miles—especially if you are carrying a canoe and fishing gear! When you need information on distance, it usually is impractical to measure the distance on foot. The easiest method is to understand the concept of map scale. Scale is the proportion between distance on the map and distance on the earth (or in the field). Since a map is smaller than the area it represents, a *ratio* can be established between map distance and actual ground distance.

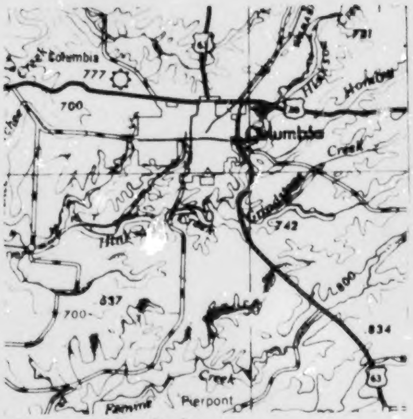
If your fishing lake were located on the map one inch from the end of the road and the scale on the map were 1:100, you could accurately say that the lake was actually 100 inches from the end of the road (1 inch on the map = 100 inches on the ground). This could then be translated into an understandable distance of about 8 feet (100 inches divided by 12 equals 8). In this case you could not only drag a boat or canoe to the lake, but take along a cooler, lawn chairs, motor, and other necessary gear.

EXAMPLES OF RATIO MAP SCALES

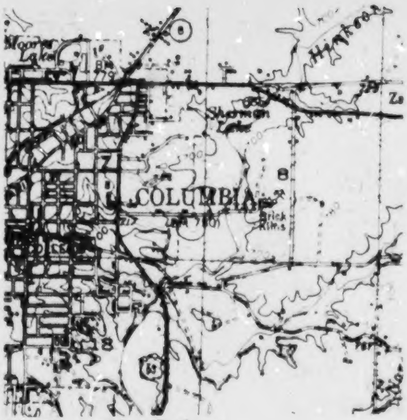
To show why a complete understanding of scale is important, let's decrease the scale of the fishing lake map to 1:250,000. In this case, the one inch from the road end to the lake on the map would be 250,000 inches on the ground—250,000 inches is much farther than the original 100 inches. In fact, the distance to the lake increased to about 4 miles (250,000 inches divided by 12 equals 20,833 feet and 20,833 feet divided by 5,280 ft/mile equals 3.9 miles).

Dragging a canoe or boat, cooler, and other gear would be quite difficult over this distance—in fact, you probably would limit your gear significantly!

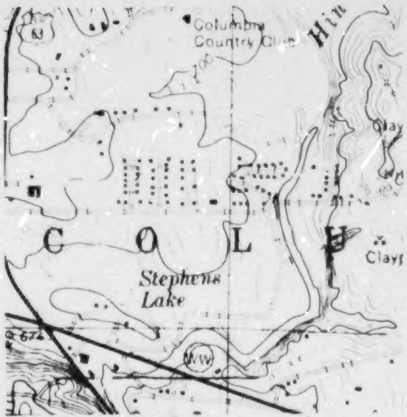
Common scales used on USGS topographic maps are: 1:250,000; 1:62,500; and 1:24,000. This means that one inch on the map represents 250,000 inches; 62,500 inches; or 24,000 inches in the field, respectively. These scales represent convenient measurements for conventional maps. They are designed to show adequate detail without being excessively



National Map Series
1:250,000 scale
1 inch = 3.9457 miles
Area shown = 97.3 square miles



15-Minute Map Series
1:62,500 scale
1 inch = 0.9864 mile
Area shown = 6.08 square miles



7½-Minute Map Series
1:24,000 scale
1 inch = 2,000 feet
Area shown = 0.87 square miles

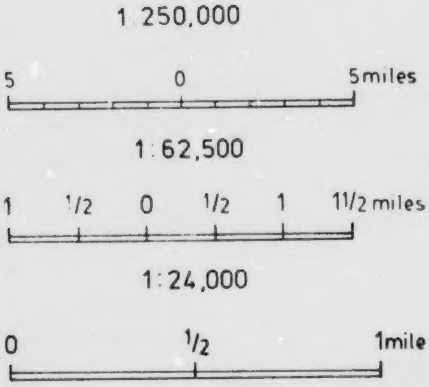
large. The smaller the scale ratio, the larger the area covered. The larger the scale ratio, the greater the detail shown. (See map examples of scales.)

At first glance, these ratios may seem rather arbitrary. But actually, they figure out to scales that people can more easily understand. This removes some of the mystery. A scale of 1:250,000 represents one inch on the map to about four miles in the field. A scale of 1:62,500 represents one inch to about one mile, and 1:24,000 represents one inch to about 2,000 feet or a third of a mile. The last scale shows the greatest detail but covers the smallest area.

Another common type of scale showing map distance to ground distance is called a graphic or bar scale. This is a small ruler type of scale that appears on the bottom of most USGS maps. The bar scale shows graphically the distances represented on the map. Usually they are read from left to right with units such as inches, feet, yards, or miles identified for the map user. All one needs to do is measure the distance from one point to another on the map and compare it to the bar scale to easily compute how far it is between the two points.

A working knowledge of both ratio scales and bar scales is essential for map users. Both scales are useful in particular instances and can be adapted to a variety of uses. Sometimes using a small hand calculator can help in doing the mathematics and computations necessary to compute scale. But remember, often a calculator is not available when you are backpacking, fishing, or hiking—so be sure to familiarize yourself thoroughly with scale before attempting to go off on your own. Try several of the exercises in the lesson plans.

Bar Scale



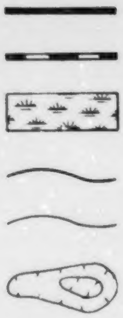
SYMBOLS

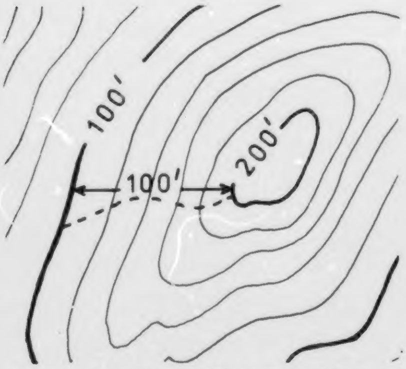
Maps are constructed with a variety of symbols. Some look like what they represent, while others may be confusing and abstract. Symbols must be used on maps to show

Map Symbol Examples

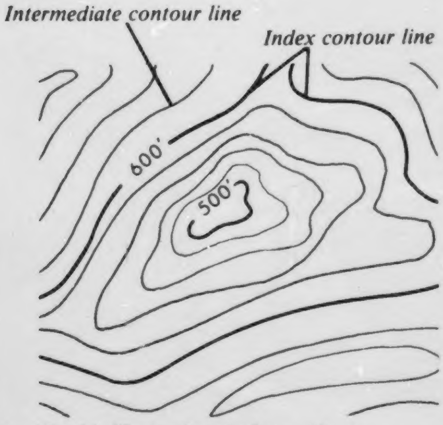
(See Appendix 1 for Map Legend)

Primary highway (red)
Secondary highway (red)
Wooded marsh or swamp (green)
Index contour (brown)
Intermediate contour (brown)
Depression contours





Contour intervals are 20 feet on this map.



In this illustration, index contour lines indicate every 100 feet. Intermediate contour lines mark every 20 feet increase in elevation.

features because it is impossible to realistically identify objects such as buildings, trees, and highways as they appear to us. Learning to identify common symbols is easy and as you begin to familiarize yourself with them, your mind often will immediately transfer the symbol on the map to what you really see when you look over the terrain.

Colors also are important to map users. If you do not understand the use of colors on a USGS map you may find yourself wading through a waist deep pond instead of a dry meadow. Colors show different types of features. Black represents man-made or cultural features; white represents open areas; blue represents water features; green represents vegetation; and brown represents elevation or "relief." Symbols and colors are used together to represent features on a map. Examples of individual symbols are shown at left and a map legend is in Appendix 1. A complete list of symbols is available from the USGS (see bibliography).

CONTOUR LINES

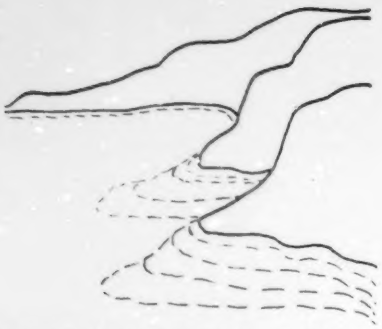
Light brown lines on the map are called contour lines. Contour lines connect points which have the same elevation. Contour lines were first used on land maps in the eighteenth century; however, they did not become popular until recently because they require that elevations be precisely determined and located on a map.

Contour lines may seem confusing at first; but with practice, you can learn to "view" contour lines as different elevations. Since each line represents the same elevation, they reflect the terrain or changes in elevation of the area and can help to interpret the landscape accurately.

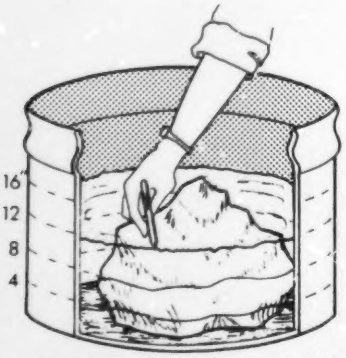
Contour lines are spaced according to regular variations in elevation called contour intervals. The contour interval of the map appears in the lower margin. Thus, a contour interval of 20 feet means that between two consecutive contour lines on the map, the actual elevation changes 20 feet. If you were hiking a trail that crossed 5 contour lines on your map in a distance of one mile, you would know that you had to climb 100 feet (5 lines x 20 feet/line equals 100 feet).

One important fact to remember is that the closer the lines are, the steeper the terrain. A meadow or field with few contour lines running through it will be relatively flat *if* the contour interval is low (i.e., 5-10 feet). That same flat-looking area could be a steep slope if the contour interval were 75-100 feet. The trail that we previously said crossed 5 contour lines in one mile only rose 100 feet, but if the contour interval were 100 feet then the rise would be 500 feet and you had better take ropes and climbing gear if you want to use that portion of the "trail."

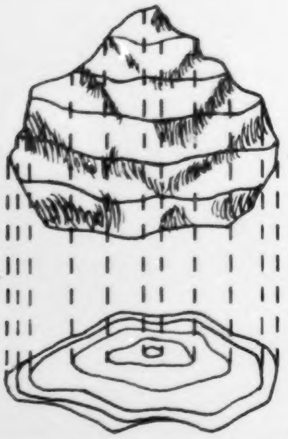
Two kinds of contour lines appear on topographic maps: index lines and intermediate lines. Numbers spaced periodically along an index line show its elevation (in feet)



Variations in the coastline as the tides rise and fall.



Marking the water level on the rock in four-inch increments.



Contour drawing of lines on the rock.

above sea level. An index line is darker in color. The lighter brown lines between index lines are the intermediate lines.

A simple way to imagine contour lines is to think of them as shorelines. Using the 20-foot contour interval as an example, imagine that the lines represent the shoreline of the ocean and that the water level is rising in 20-foot increments. Thus, contour lines close together indicate a steep shoreline while lines spaced farther apart represent a more gentle drop.

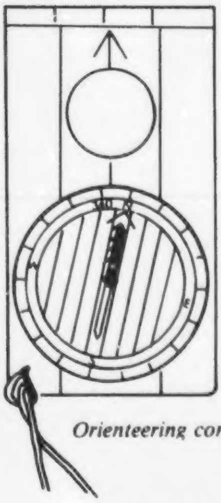
Another way to understand contour lines is to use a large (basketball size), irregular object like a rock. Set the object in a watertight tub deep enough to submerge the entire object. Looking down on the object, draw a line with a grease pencil around its widest circumference. Now fill the tub with water to the depth of four inches. Mark the waterline on the object with the grease pencil. Add water to raise the water level by another four inches and repeat the marking procedure. Continue until the object is completely submerged. Now remove it from the tub. It should be inscribed with a series of irregular, concentric circles. Looking down on the object from directly above, draw its outline and the various waterlines on a piece of paper. The completed drawing is a contour map of the object—a two-dimensional representation of a three-dimensional object. The contour interval in this instance is four inches.

The skill of interpreting topographic maps is not difficult, but it does require practice. Some of the activities listed at the end of the module will help you develop this skill. To obtain topographic maps, see the bibliography.

Compasses

Once the basic skills of map interpretation have been mastered, it is time to work on the skill of compass reading.

The compass is the basic direction-finding device in terrestrial navigation. There are three categories of compasses: magnetic compasses depend on the earth's magnetic field, gyrocompasses rely on the rotation of the earth, and solar compasses use the location of the sun and stars. For our purposes, the magnetic compass is the simplest to use, and further discussion will be confined to this type of instrument.


Orienteering compass

Magnetic compasses

There are several types of magnetic compasses. Some have special uses and others are for general use.

For serious map and compass work, the best type of compass is an *Orienteering compass* (see diagram). This compass is especially designed for use with topographic maps and is inexpensive and durable.

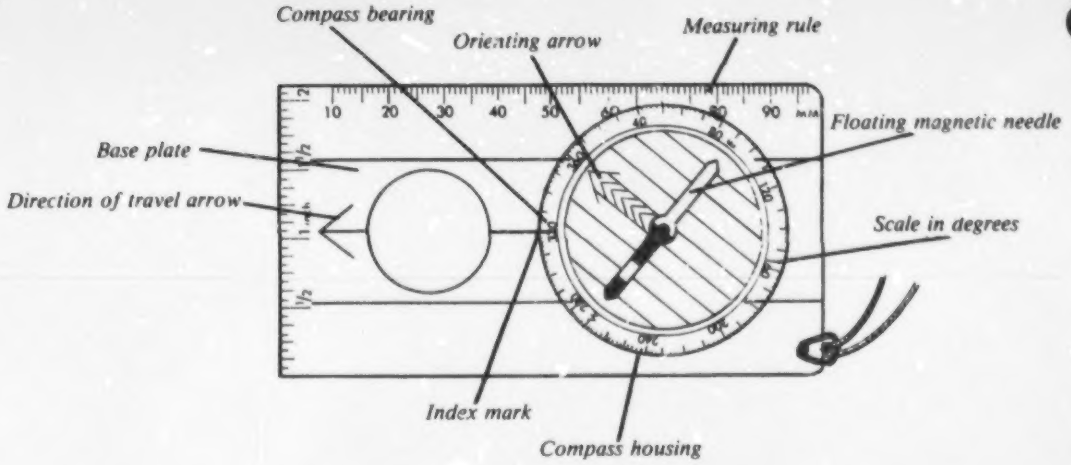
Basic principle of a compass

The magnetic compass works on the principle that the earth is a giant magnet and generates a magnetic field running north and south exactly like a bar magnet. A freely suspended iron needle will align itself with the lines of magnetic force of the earth. There are several difficulties with the use of a magnetic compass. First, the earth's magnetic field does not coincide exactly with its polar axis. Thus the magnetic north pole and the true North Pole are some distance apart. As you will learn in this unit, however, it is quite easy to correct the error caused by this discrepancy. If you are close to the North Pole, however, the compass needle tends to point south. For general use in our area, this is not a major problem. Finally, metal objects, such as belt buckles, boats, automobiles, or even large iron ore deposits in the earth, can cause a compass to give misleading information. The metal interferes with the compass needle's response to the magnetic north pole. These are minor problems and can be easily corrected if you are aware of a compass' limitations.

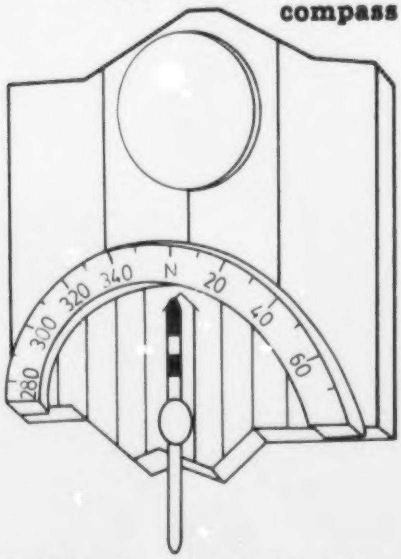
Parts of an Orienteering compass

The Orienteering compass consists of three basic parts: magnetic needle, a revolving compass housing, and a transparent base plate. Each has its own special function. Together they give you instant directions, combining compass, protractor, and ruler into a single tool.

Etched on the bottom of the housing is the orienting arrow. Around the housing margin is the scale graduated in 360 degrees of a circle (north is at 0 degrees and south is at 180 degrees). The compass housing can be rotated on the base plate independent from the needle. Inscribed on the base plate, in line with the direction-of-travel arrow, is the index mark. The number appearing over or adjacent to the index mark is called the compass bearing.



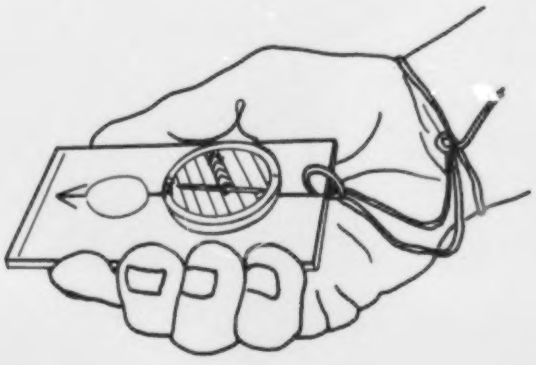
Finding direction using a compass



To find north, set your compass to look like this.

Finding direction with an Orienteering compass is easy. To locate a specific direction—for example, north—rotate the compass housing so 0° (north) is directly over the index mark. Hold the compass at your waist. Be careful of nearby metal objects, such as belt buckles, automobiles, or metal buildings which might influence the needle. Turn your body holding the compass steady until the red end of the floating needle is aligned with the orienting arrow etched on the bottom of the compass housing. Look up—the direction you are facing is north. This procedure is called "setting a bearing."

To determine the direction of a distant object with an Orienteering compass, face the direction in question. Hold the compass either waist or chest high with the direction-of-travel arrow pointing straight ahead and the protractor plate level. Now rotate the compass housing until the floating needle is aligned over the orienting arrow etched on the bottom of the compass housing. The north end of the needle should point toward the tip of the orienting arrow. Read the bearing, in degrees, from the scale at the index mark. This procedure is called "taking a bearing."

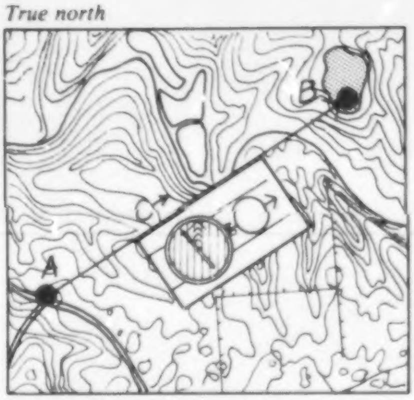


Hold the compass at waist level with the direction of travel arrow pointing straight ahead, then rotate the compass housing until the floating needle (red end) is aligned over the orienting arrow. Keep the compass level.

Finding direction from a map

Finding direction from a map is just as simple. First note that the top of the topographic map is true north. Select a point on the map to serve as a base or reference point—a road junction, for example. Select a second point, such as a pond, to serve as a destination. An arrow drawn from the reference point to the destination point indicates the direction of travel. Place the compass on the map so that the base plate lies along the direction-of-travel line you have drawn on the map. The direction-of-travel arrow on the compass should also point in this direction. With the compass in this position, rotate the compass housing until the orienting arrow etched on the bottom of the compass points north (top of the map). Read the bearing on the compass dial at the index mark. This compass bearing is then the direction you should follow from the road junction to the pond.

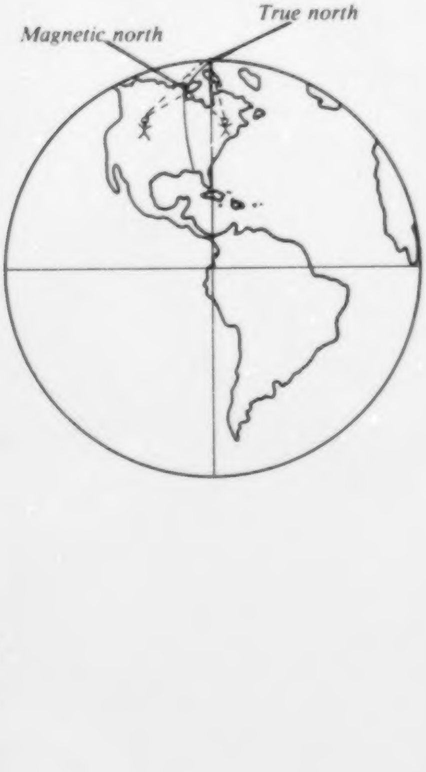
Note that the floating needle is ignored throughout this procedure. Also note that the bearing arrived at is the true bearing. It probably will not be the same bearing obtained from actual measurements in the field. The next section explains why.



A = Reference point (road junction)
B = Destination (pond)
C = Direction-of-travel line
60° = Bearing at index mark

Using Map and Compass Together

A compass needle points toward magnetic north. The top of a topographic map indicates true north.

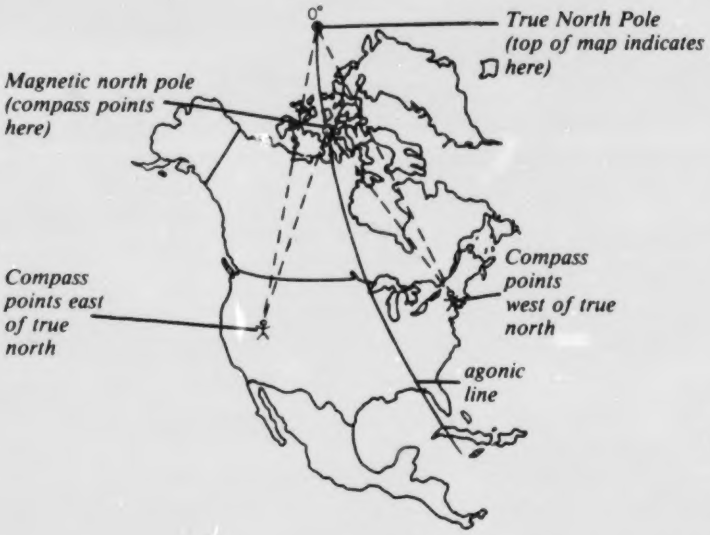


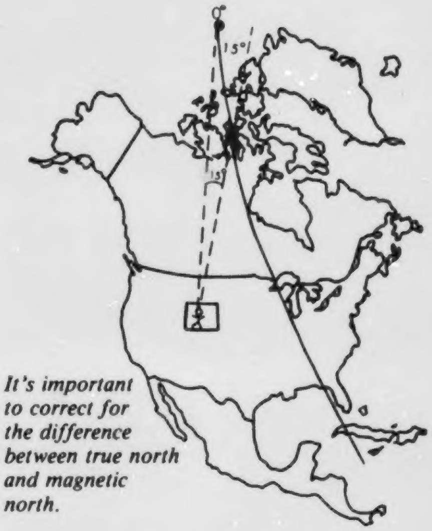
As mentioned earlier, map and compass are a team. Each can work independently, but they function best together. Before you use map and compass together, however, it is necessary to understand some of the limitations of each.

A compass needle points toward magnetic north. The top of the topographic map indicates true north, which differs from magnetic north.

True north is the actual north polar axis of the earth. Magnetic north is an area near Hudson Bay—over 1,000 miles from the true North Pole. It is difficult to give an exact location for the magnetic north pole because it moves. Reasons for this movement are complex and changes occur irregularly over hundreds of years. The difference between true north and magnetic north can vary greatly in different parts of the U.S. The only place in our hemisphere where true north and magnetic north coincide is on a line (called the agonic line) that runs from the west coast of Florida through Lake Michigan to the magnetic north pole. At any point between this zero line and the Atlantic Ocean, the compass needle points west of true north. At any point between the zero line and the Pacific Ocean, the floating needle points east of true north.

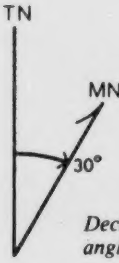
This discrepancy between map "language" and compass "language" is extremely important to anyone using map and compass together. For example, consider a hiker or hunter in Wyoming where the compass needle points 15 degrees east of


0°
True North Pole (top of map indicates here)
Magnetic north pole (compass points here)
Compass points west of true north
Compass points east of true north
agonic line



It's important to correct for the difference between true north and magnetic north.

true north. If the sportsman takes a bearing from his map and sets it on the compass without correcting for the 15-degree error and then starts following the bearing, he will be one-fourth mile off course after only one mile of travel. For every four miles he walks, he will move a full mile farther off course. In Missouri, declination varies 5½ to 6 degrees so it is not such a significant difference. Fortunately, there is a simple procedure for making map and compass speak the same language.



Declination symbol showing 30° angle to the east.

Declination

The angular variation between true north and magnetic north is called declination. A knowledge of declination is used two ways: (1) to adjust a compass (magnetic) reading to a map (true reading) and (2) to convert a true reading (taken from a map) to a magnetic reading that can be followed with a compass.

A symbol for declination, accompanied by a number, appears in the lower margin of all USGS topographic maps. The number is the declination for the area covered by the map. The symbol indicates whether the declination is east or west.

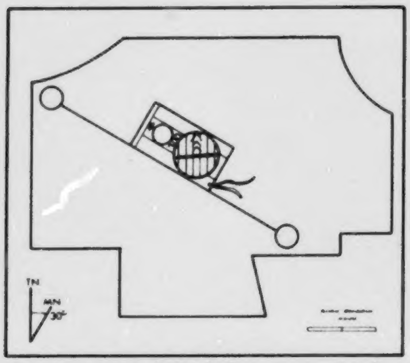
Two kinds of bearings are used with map and compass. A bearing taken from an object on the landscape is a *compass bearing*. It must be converted to a true bearing to be transferred to the map. When transferring compass bearings to a map, you must add easterly declination and subtract westerly declination, which is exactly the opposite of the adjustment you make when working from map to compass. A bearing taken from the map is called a map bearing or *true bearing* and must be converted to a compass bearing before use in the field. To follow a bearing taken from a map with a compass, you must subtract easterly declination and add westerly declination.

For example, consider again the sportsman in Wyoming. As explained, failure to correct for the 15 degree easterly

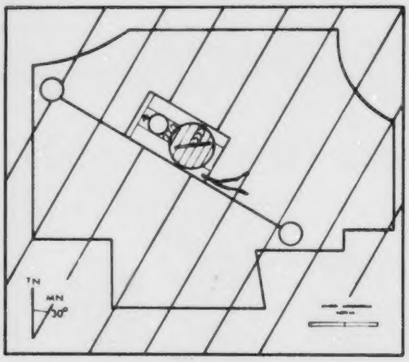
Correct declination mathematically:

Declination east—compass least (subtract)
Declination west—compass best (add)

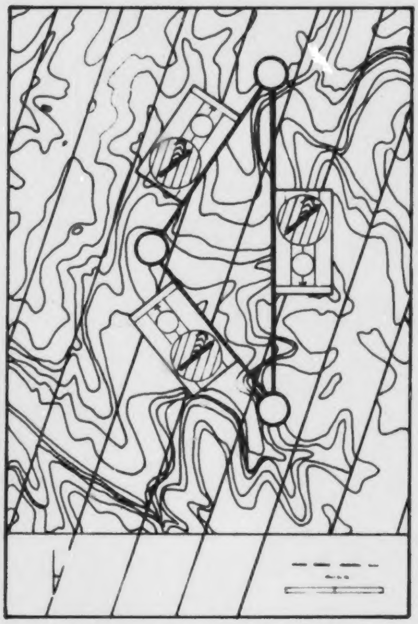
Correct declination on the map:



Compass reads 300° before correcting for 30° declination.



Extend magnetic north lines across page. Rotate compass housing so orienting arrow is parallel with magnetic lines. Now compass reads 270°.



Map with magnetic lines drawn. This method avoids adding and subtracting declination.

declination could put the person seriously off course. To prevent this, the sportsman should reset his compass. Because the compass needle points 15 degrees east of true north, 15 degrees should be subtracted from the map bearing (true bearing) to be followed. Subtracting compensates for the easterly error. Anyone following a map course in the eastern U.S., where the declination is west would correct the bearing by adding the appropriate number.

A simple device for remembering whether to add or subtract declination is the rhyme: "Declination east—compass least; declination west—compass best." So, for an easterly declination, the compass bearing should be less than the true bearing (compass least—subtract). For a westerly declination, the compass bearing should be greater than the true bearing (compass best—add). This procedure applies whenever a compass is set to a true (map) bearing (converting true bearing to magnetic bearing).

When you are using maps in the field, you can use a simpler method to correct the declination.

1. With a pencil and straightedge, extend the magnetic north arrow in the bottom margin of the map across the face of the map.

2. Draw a series of lines parallel to the first line about 2 inches apart. Space them evenly over the entire surface of the map.

3. Now, to take a map bearing, use the same procedure explained in the map section with one important exception: instead of rotating the compass housing until the orienting arrow is pointing to the top of the map, or true north, rotate the housing until the orienting arrow is aligned with the magnetic north lines you have penciled in. Any bearing taken from the map using this procedure can be followed directly in the field—without other compensation for declination.

This method avoids adding and subtracting because instead of aligning the compass orienting arrow with the top of the map, you align it with magnetic north. Thus all bearings are automatically converted to map "language" or true bearings. Similarly, any bearing taken from an object in the field can be plotted directly on the map, using the magnetic north lines, without further compensation for declination. By drawing those lines lightly on the map, all the adding and subtracting is unnecessary.

Following a compass course taken from a map

Steps in following a map course with a compass are easy.

1. First, on the map, align the direction-of-travel arrow on the compass with the desired route. Disregard the floating needle.

2. Now set the compass housing so that the etched orienting arrow in the base of the compass housing is aligned with the magnetic north lines you have drawn on the map.

3. If you have not added magnetic north lines, rotate the compass housing until the orienting arrow points to the

top of the map (north) and then add or subtract the proper declination to the bearing shown.

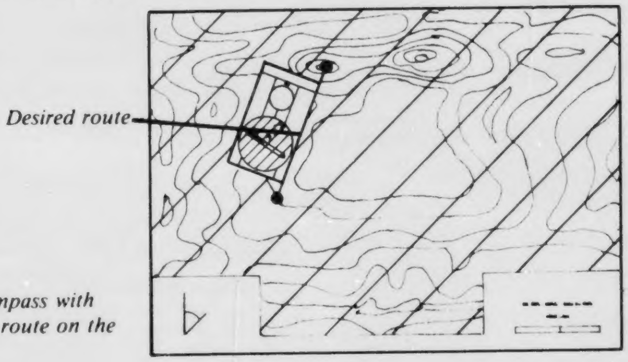
4. Make sure the compass base plate stays aligned with the travel route shown on the map until the bearing is read. Now take the compass off the map and hold it level at waist height with the direction-of-travel arrow pointing ahead.

5. Slowly turn your body until the floating needle is directly over the etched orienting arrow. The direction-of-travel arrow on the compass base plate now points toward the destination shown on the map.

When you are on a compass course, it is best to follow visible landmarks along the route. Take short sections of a long route and walk from landmark to landmark rechecking the bearing periodically. This is safer and faster than charging over the landscape for long distances with your head down, watching the compass needle.

When you work with map and compass in the field, position the map so that its direction corresponds to directions in the field. To orient a map, simply set the compass to zero bearing and align the base plate with one of the magnetic north lines. Turn the map and compass together until the floating needle is aligned with the orienting arrow. The map is now oriented to the landscape so objects in the field will appear in the same direction as on the map.

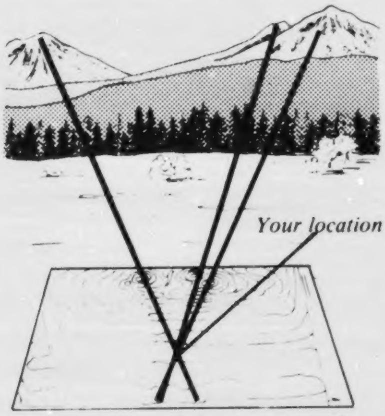
Don't forget to look where you are going.



Align the compass with your desired route on the map.

Resectioning

The compass is used most often to follow a route laid out on a topographic map. Sometimes, however, you may want to take compass bearings from objects in the field and plot their location on a map. Outdoor enthusiasts can use this procedure, called resectioning, to identify a favorite spot for fishing, hunting, or other activity. Resectioning has only one prerequisite—there must be at least two, but preferably three, identifiable points on the landscape that also appear on the map.



Align landmark with its symbol on the map.

RESECTIONING WITHOUT A COMPASS

To resection without a compass:

1. Orient the map by inspection—that is, align the map on the ground so that the two or more landmarks selected to serve as references appear on the map in the same orientation that they appear on the landscape.

Take a compass bearing from first landmark.

2. With a straight stick, align the distant landmark with its symbol on the map.

3. Draw a line across the map so that when you sight over the line, the distant landmark appears.

4. Repeat this procedure for each landmark without moving the map.

RESECTIONING WITH A COMPASS

To resection with a compass:

1. Select three landmarks to serve as reference points.

2. Take a compass bearing from your location to the first landmark.

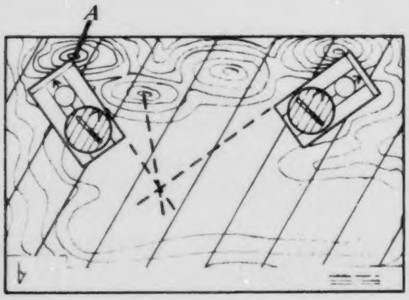
3. Transfer the bearing to the map by laying the compass on the map so that the edge of the base plate touches the landmark symbol. (See A on diagram.)

4. Without changing the bearing, swing the entire compass (keeping the edge of the base plate on the landmark) until the orienting arrow becomes aligned with the magnetic north lines drawn on the map. Make sure your orienting arrow points in the proper direction. If you have not drawn magnetic north lines, you will need to correct for declination.

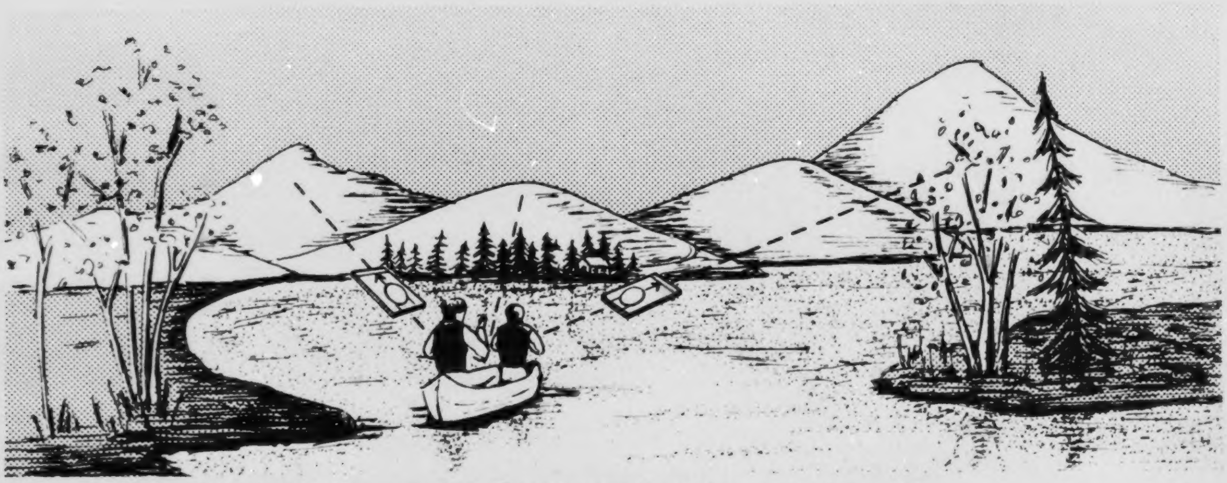
5. Draw a line passing through the landmark symbol using the compass base plate as a straightedge.

6. Take a compass bearing from the other landmarks and transfer to the map as before. The point or area at which the lines intersect is your location.

For best results when resectioning, use landmarks that are at about 45-to 90-degree angles from each other. Landmarks within 45 degrees of each other are subject to greater error. Often you have small errors in your readings. Thus, if you use three points when you resection, you create a "triangle of error." Your location is within this triangle of error. If this triangle is extremely large, recheck your bearings. One of them may be miscalculated.



Transfer your bearing to the map.



When resectioning, use landmarks that are at about 45-to 90-degree angles from each other.

Orienteering

Recreational map and compass reading

A map and compass are not only useful for activities such as hiking, fishing, or hunting. Many people use them as recreation in their own right. There are games and activities involving map and compass skills that can be integrated with other outdoor skills (see references in bibliography).

Competitive Orienteering

The use of map and compass in competitive games is called *Orienteering*. This sport challenges both mind and body as contestants pit map and compass skills against time in an effort to cover specially laid out Orienteering courses.

For more information on Orienteering, consult the bibliography.

Lesson Plans

Note to instructor: If you are doing map and compass activities with a student who is in a wheelchair, remember that the compass will be affected by the metal in the wheelchair.

The following lesson plans are offered as a suggested and field-tested means of teaching this subject material. Activities provided have been taught by teachers, Department of Conservation education personnel, and youth leaders.

Times are estimated for 50-minute class periods, however, the time needed for each lesson may vary depending upon the teacher and class. Pages marked as student handouts in the appendix should be reproduced for distribution.

No. 1

Title:	Introduction to Course and Maps
Method:	Lecture, film (27-minute and 14-minute versions of "By Map and Compass")
Time:	50 minutes
Purpose:	To introduce students to the course and acquaint them with types of maps and their uses; to teach students basic map interpretation skills
Instructional Aids:	Film; road, soil, geological, and land-use maps; topographic maps of school area (for sources of maps, see bibliography)
Facilities:	Classroom

Outline:

I. Introduction
  A. Uses of map and compass in daily activities
    1. Everyone uses map and compass directions directly or indirectly.
      a. Planning vacations
      b. Drawing map to home or campsite
      c. Interpreting directions given by another
      d. Giving directions
    2. Ask students how they have used a map or compass.
  B. Special uses of map and compass
    1. Outdoorsmen use map and compass in pursuit of recreation.
      a. Safety/avoiding getting lost
      b. Locating hunting and fishing spots
      c. Hiking cross-country, backpacking

Note to instructor: Show film "By Map and Compass" as part of introduction to course. The film is available for rental or sale from International Film Bureau, Inc., 332 South Michigan Ave., Chicago, IL 60604, 312/427-4545.

2. Professionals use map and compass in their jobs.
    a. Engineers
    b. Surveyors
    c. Foresters
    d. Soldiers
    e. Guides
    f. Geographers
    g. Geologists

II. Maps
  A. Definition
    A reduced representation of a portion of the earth's surface.

Class Demonstration:

  B. Types of maps—explain with samples
    1. Road maps are most familiar. (Obtain free copies from the Missouri Highway and Transportation Department.)
    2. Soil maps tell what kind of soils are found in a given area. (Free maps are available from state and county Soil Conservation Service offices.)

Materials needed: Samples of maps.

    3. Geological maps show only the geological structure of an area. (Obtain from Department of Natural Resources—Land Resources—Rolla.)
    4. Land-use maps show how an area is being used. (Borrow aerial photographs from local Agricultural Stabilization and Conservation Service offices.)
    5. Topographic maps show the physical characteristics of an area. (Order from USGS—see bibliography.)

Activities:

I. Have students write directions for reaching their home from school. Directions should include distances.
II. Have students draw a map showing how to reach their home from school. Make sure directions and symbols are used.

No. 2

Title:	Topographic Maps
Method:	Lecture, demonstration, activities
Time:	50 minutes (allow up to half a day for activities)
Purpose:	To teach students basic skills for interpreting topographic maps
Instructional Aids:	Topographic maps of any area; topographic maps of school area or field site (for sources of topographic maps, see bibliography); irregular rock approximately basketball size; water tub large enough to submerge rock; water source; grease pencil
Facilities:	Classroom, schoolyard, or field site

Outline:

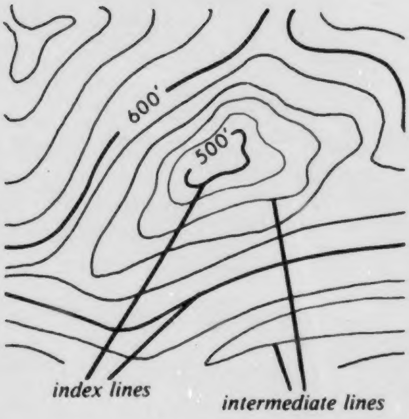
I. Topographic Maps vs. Road Maps
   A. Both are representations of an area of the earth's surface.
   B. Road map plots position and distance of cities and roads but tells nothing about terrain.
   C. Topographic map shows physical characteristics of an area as well as cultural features.

II. Reading a Topographic Map—distribute topographic maps and legend sheets (Appendix 1)
   A. Map descriptors are located in the margins of the map.
   B. Locate the following:
      1. Map name
      2. Names for maps of adjacent areas
      3. Longitude and latitude of area of map
      4. Dates when map was made and field-checked
      5. Map scale
   C. Map scale (shown in lower margin) indicates linear distances which may be used to calculate the area covered by a map.
      1. Scale is the proportion between a distance on the map and the actual distance on the earth.
      2. Scale is expressed as "map units: actual units."
      3. Common scales are 1:250,000; 1:62,500; 1:24,000.
      4. 1:250,000 means that 1 unit on the map represents 250,000 units on the earth (1 inch on the map represents 250,000 inches in the field).
      5. The smaller the scale ratio, the larger the area covered by the map; the larger the ratio, the greater the detail shown.

Materials needed: Topographic maps, legend sheets (Appendix 1).

6. Scale ratios figure out to scales that can be remembered more easily. 1:250,000 is a scale of 1 inch to about 4 miles: 1:62,500 represents a scale of 1 inch to about 1 mile; 1:24,000 represents a scale of 1 inch to about 2,000 feet or about 4/10 of a mile.

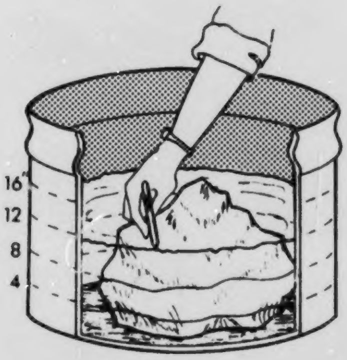
D. Map symbols—refer to legend sheets.
  1. Colors show different kinds of features—find examples of different features on the topographic map.
    a. Black for cultural (man-made)
    b. Blue for water
    c. Green for vegetation
    d. Brown for elevation
    e. Red for urban areas
    f. Purple for recent changes in land use
    g. White for open areas
  2. Elevation is shown by brown lines of various weights.
    a. Brown contour lines show ups and downs or relief of terrain.
      (1) Heavy brown contour lines are index lines and bear a number which corresponds to elevation above sea level in feet.
      (2) Lighter brown contour lines are intermediate lines and occur at vertical intervals called contour intervals.
    b. Contour interval, given in the lower map margin, means the vertical distance between adjacent lines on the map.
    c. Contour lines can be imagined as shorelines if the ocean were to rise by the distance shown on the index lines.

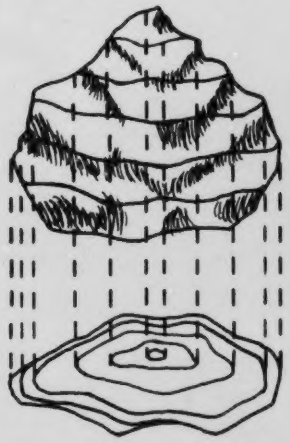


Class Demonstration:

III. Understanding Meaning of Relief and Contour Lines
  A. Obtain a large rock (basketball-size).
  B. Looking directly down on the rock, draw a line around the edge of the rock with a grease pencil.

Materials needed: large rock, tub to hold water, water, grease pencil





C. Now set the rock in a watertight tub and add water to a depth of 4 inches.
D. Trace the waterline on the rock with the grease pencil.
E. Raise the water level by another 4 inches and trace the waterline. Repeat until the rock is completely submerged.
F. Remove the rock and, looking directly down on it, draw the outline of the rock and the consecutive waterlines on the piece of paper.
G. The finished drawing is a contour map of the rock. The contour interval in this case is 4 inches.

Activities:

I. Map Walk
  A. Have students take an imaginary hike using the topographic map.
  B. Ask them to lay out a route and then imagine they are hiking along it, describing as they go whether they are going uphill or downhill, following a stream, etc.
  C. Variation: If all students have the same topographic map, one student can "run," describing the route while others try to catch that person by calling "stop" when they think they have identified the route.
II. Matching contour lines with verbal descriptions—see Appendix 2.
III. Pairing profiles and contour lines—see Appendix 3.
IV. Working with topographic maps—see Appendix 4.
  A. Contour lines
  B. Contour elevation notations
  C. Contour intervals
  D. Hilltops
  E. Cliffs
  F. Depressions
  G. Stream beds
  H. Landforms
  I. Evaluation exercise

No. 3

Title: Compass (Part I)

Method: Lecture and activities

Time: 50 minutes

Purpose: To teach students basic operation of compass, including how to take bearings from objects in the field and how to follow a compass course

Instructional Aids: Orienteering compasses; other aids as required by specific activities listed under activities; student handout "The Parts of a Modern Orienteering Compass," Appendix 5

Facilities: Classroom, schoolyard, or field site

Outline:

I. Compass
- A. Types of compasses—show example of Orienteering compass
    1. There are many types of compasses; some have special uses.
    2. An Orienteering compass is the best choice for serious map and compass work.

Class Exercise:

Materials needed: Orienteering compasses, handout (Appendix 5).

Note to instructor: Your main cost will be compasses. You should plan to have one Orienteering compass for every two students, if possible. If your school or camp does not have money for compasses, plan a fund-raising activity. The 1983 prices for a starter compass are $5.50, although educators and youth leaders can receive a 20 percent discount. For more information, write Orienteering Services, USA, Box 1604, Binghamton, NY 13902, 607/724-0411.

- B. Parts of an Orienteering compass
    1. Distribute Orienteering compasses and student handout "The Parts of a Modern Orienteering Compass," Appendix 5.
    2. Have students identify the following:
        - a. Base plate with measuring rule, and direction-of-travel arrow.
        - b. Compass housing with orienting arrow on bottom.
        - c. Graduated scale on ring around housing.
        - d. Magnetic needle with north end red.
        - e. Index mark for reading bearing.

Class Exercise:

Note to instructor: Do not attempt to use a compass indoors because metal chairs, beams, window frames will influence the floating needle. Do all bearing activities outdoors.

- C. Finding direction with a compass.
  Have students perform the following procedure as you demonstrate:
    1. Face a distant object (tree, building, or pole).
    2. Hold compass waist high with direction-of-travel arrow on base plate facing straight ahead toward object selected.
    3. Rotate compass housing until floating needle is aligned with orienting arrow etched on bottom of housing. North end of needle should point in direction of orienting arrow and direction-of-

travel arrow should remain pointed at selected object.

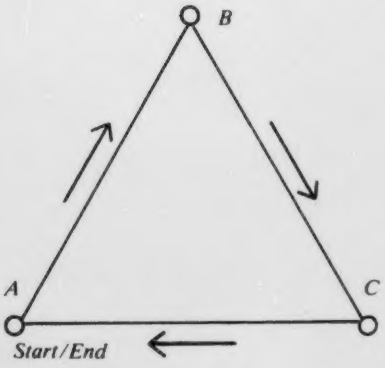
4. Read compass bearing—in degrees—on scale on compass housing at index mark. (On some compasses the tail of the direction-of-travel arrow serves as the index mark.)
5. Compass scale gives bearings in degrees of a circle: north is 0° or 360°; east is 90°; south is 180°; west is 270°.

Activities:

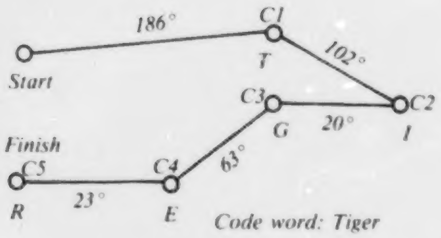
I. Making a Temporary Compass
  A. Materials needed—needle, silk (4" x 6"), saucer of water, blade of grass
  B. Procedure
    1. Stroke needle vigorously from head to tip with silk, which magnetizes the needle.
    2. Coat needle with skin oil obtained by rubbing finger against side of nose or across forehead.
    3. Using blade of grass as a sling, gently lower needle into saucer of water so that the needle floats on top of the water.
    4. Needle will align with head pointing north.

II. Bearing Drill
  A. Materials—Orienteering compasses
  B. Procedure
    1. Call out a bearing and have students set their compasses. Example: Call out "70°"—students should set compass to 70°.
    2. Holding compass properly with direction-of-travel arrow facing ahead, have students turn their bodies until the floating needle is aligned with orienting arrow.
    3. Variation:
      a. Choose a landmark and have students take a bearing on it. (Use distant landmarks to minimize differences in bearing caused because students are not standing in the same spot.)
      b. Pick a distant landmark and take a bearing. Call out bearing. Have students set bearing and orient themselves. See if they pick the landmark you have selected.

III. Back to the Beginning Drill
  A. Materials—Orienteering compasses
  B. Procedure
    1. Have students set compasses to 40° and walk 3 paces.
    2. Have students reset compasses to 160° and walk 3 paces.
    3. Have students reset compasses to 280° and walk 3 paces. They should end where they began.
    4. Ask students what type of figure they walked.



IV. Hidden Code Word
   A. Materials—Orienteering compasses, control point markers (stakes or flags), index cards, code breaker cards
   B. Procedure
      1. Set up a short compass course in schoolyard or classroom according to diagram at left.
      2. Select a code word with the same number of letters as there are control points. (Example at left is "Tiger" for 5 control points.)
      3. At each control point, place an index card marked with one letter of the code word. Arrange the cards so that when the course is followed correctly, the code word will be spelled.
      4. Give students a code breaker card (see example at left) with bearings for following the course. Since no distances are given, a map is not necessary.
         NOTE: Control points should be close enough together that the course is not obvious, but far enough apart to allow for slight errors in setting bearings.



Code word: Tiger

Code Breaker Card

		Letter
Start-C1	*186°*	___
C1-C2	*102°*	___
C2-C3	*20°*	___
C3-C4	*63°*	___
C4-Finish	*23°*	___

V. Additional Activities
   If time permits, the following activities are recommended for this lesson:
   A. Fifteen Degrees—pg. 56.
   B. Magnetic Influence—pg. 51.
   C. Left Leg, Right Leg—pg. 50.

No. 4

Title: Compass (Part II)

Method: Lecture and activities

Time: 50 minutes

Purpose: To teach students basic skills of direction-finding with a compass, including finding directions from a map

Instructional Aids: Orienteering compasses; topographic maps

Facilities: Classroom

Outline:

I. Finding Direction From a Map
- A. Distribute maps and compasses.
- B. Explain the following and have students follow the procedure you indicate:
  1. The top of the topographic map always indicates true north.
  2. Have students select a point on the map to serve as a reference or "starting" point.
  3. Have them select a second point to serve as a destination.
  4. A line drawn between the two points with an arrow pointing toward the destination indicates the direction of travel or route.
     NOTE: Rather than have students draw on maps, you may want to make copies.
  5. Have students place compass on the map so the side of the base plate lies along the direction-of-travel line with the direction-of-travel arrow on the base plate pointing toward the destination.
  6. Have them rotate the compass housing until the orienting arrow on the bottom of the housing points toward the top of the map.
  7. Have them read the route bearing at the index mark on the compass dial.
     NOTE: Ignore the floating needle throughout this procedure.
  8. The dial gives the true bearing of the destination from the starting point. Remind group that this may not be the bearing the compass would give if you were standing on the landscape and taking an actual bearing. The reason is explained in the next lesson.

Materials needed: Orienteering compasses, topographic maps.

Activities:

I. Imaginary Backpacking Trip
- A. Materials—topographic map of an area within a national park or forest
- B. Procedure
  1. Instructor should mark campsites on the map.
  2. Tell student "hikers" they cannot travel more than 12 miles per day.
  3. Have hikers compute bearings from campsite to campsite on the map.
  4. In selecting their route, students should consider the terrain as shown on the map—not simply the shortest distance between two campsites. Remind them that people do not travel in a straight line, but instead follow creek valleys, ridge tops, old trails, and other features of the terrain.
  5. "Hikers" should draw the route on the map and keep a diary of travel including route bearings,

description of terrain, and reasons for selecting a particular route.
NOTE: To preserve maps, make copies for students.

SAMPLE DIARY ENTRY:

"Day 1. Left parking lot on bearing of 87° until I reached Hazard Creek. Terrain rugged, so I followed the creek to Stillhouse Cave. Traveled from cave to campsite on a bearing of 131°. Crossed a large meadow and climbed two steep hills. Distance traveled first day—7 miles."

II. Additional Activities
If time permits, the following activities are recommended for this lesson:
- A. Going from Point to Point—pg. 52.
- B. Fifteen Degrees—pg. 56.
- C. Three-Legged Traverse—pg. 51.
- D. Running a Square—pg. 50.

No. 5

Title: Using Map and Compass Together (Part I)

Method: Lecture and activities

Time: 50 minutes or longer depending on activities

Purpose: To teach students the skill of following a compass course taken from a map; to teach students the significance of declination and the proper procedure for compensating for declination

Instructional Aids: Globe, declination map of North America (Appendix 6), Orienteering compasses; topographic maps of school area or field site

Facilities: Classroom, schoolyard, or field site

Outline:

Note to instructor: An understanding of declination is essential to using compass and map together successfully. Instructor should understand thoroughly the concept of declination before presenting it to the class.

Materials needed: Globe

I. Declination
- A. Distribute topographic maps, compasses.
- B. Explain that a compass needle points toward magnetic north pole, an area near Hudson Bay.
- C. Topograpic maps are oriented so the top of the map indicates true north or the north polar axis of the earth.
- D. On a globe, identify for the class both the geographic (true) and magnetic north poles.

E. Demonstrate that a compass (use a pencil as a compass needle) positioned at different points on the globe will not always point toward true north. Do this by holding the pencil at different points on the globe with the pencil always pointing toward the magnetic north pole.

F. Explain that it is possible for a maximum difference of 30° to exist between true and magnetic north in the United States. This difference is called declination.

Materials needed: Declination maps of North America (Appendix 6).

G. Distribute declination maps of the United States (Appendix 6), and explain that this illustrates the declination for various points in the U.S.

H. Explain that declination must be considered in following a compass course taken from a map. Failure to consider declination will result in course errors equal to the declination of the area being considered.

   1. There is one area in the United States where declination does not need to be considered because the declination is zero. This area is along a line called the agonic line which runs from the west coast of Florida through Lake Michigan to the magnetic north pole.
   2. If the declination of an area is 15° and this is not considered in setting a compass course from a map, the resulting error will be 1/4 mile for each mile traveled. In other words, a hiker setting off on an 8-mile hike would be 2 miles off course after hiking 8 miles.

I. Declination is given as east or west.

J. Identify the symbol in the lower map margin that indicates declination and whether it is east or west.

K. To reset a compass for a westerly declination, take the compass bearing indicated on the map (according to the procedure in Lesson No. 4) and ADD the degrees of declination to that setting. Reset the compass to this new bearing.

L. To reset a compass for an easterly declination, take the map bearing and SUBTRACT the degrees of declination. Reset compass to this new bearing before following the compass.

Have students learn the ryhme:
Declination east—compass least (subtract)
Declination west—compass best (add)

M. Remember the rhyme: "Declination east—compass least, declination west—compass best" to decide whether to subtract or add declination to map bearing.

A simpler way to compensate for declination is to alter the map.

N. A simpler way to compensate for declination is to alter the map.

   1. From the magnetic north arrow in the declination symbol in the map margin, extend a pencil line across the face of the map.
   2. Draw a series of lines parallel to the first line and evenly spaced across the face of the map.

Note to instructor: For declination of 5° or greater, the angle represented by the symbol is accurate. However, for angles less than 5°, the symbol is representative and the actual declination should be measured from one of the side margins.

3. To take a bearing using the altered map, follow the procedure in Lesson No. 3; however, instead of rotating the compass housing until the orienting arrow points to the top of the map, rotate the housing until the orienting arrow is aligned with the penciled magnetic north lines. The compass bearing is automatically corrected for declination.

Class Exercise:

Materials needed: Topographic maps of area (see bibliography), compasses.

II. Steps in Following a Compass Course Taken From a Map

Have students follow these steps as you demonstrate. Before beginning, students should pencil magnetic north lines on their maps according to the procedure just given.

A. On the map, line up compass with desired route with direction-of-travel arrow on compass base plate pointing toward destination. Disregard floating needle.

B. Rotate compass housing so orienting arrow aligns with penciled magnetic north lines. Disregard needle. Keep base plate aligned with route. Compass is now set.

C. Hold compass level with direction-of-travel arrow facing ahead. Turn body until floating needle is aligned over orienting arrow. Direction-of-travel arrow now points toward destination shown on map.

D. Follow compass course by picking landmarks on route and walking from landmark to landmark, checking bearing occasionally. Do not watch compass face continuously.

Activities:

I. Repeat activity in Lesson No. 4, having students give corrected bearings.

II. Propose hypothetical hikes in different parts of the country. Give compass bearings (uncorrected) and have students use U.S. declination map (Appendix 6) to determine approximate declination correction.

EXAMPLE: Propose a compass course of 62° uncorrected in Wyoming. Ask students what the compass setting should be. Students, by referring to U.S. declination map, will see that declination in Wyoming is approximately 15° east. Compass course should be 62° - 15° = 47°. (Remember: declination east—compass least)

III. Additional Activities

If time permits, the following activities are recommended for this lesson:

A. Magnetic Influence—pg. 51.

B. Left Leg, Right Leg—pg. 50.

C. Geometric Figures with a Magnetic Compass—pg. 52.

No. 6

Title: Using Map and Compass Together (Part II)

Method: Lecture and activities

Time: 50 minutes or longer depending on activities

Purpose: To teach students procedure for resectioning or plotting position on a map from bearings taken in the field

Instructional Aids: Topographic maps of school area or field site, Orienteering compasses, materials for activities as specified

Facilities: Classroom, schoolyard, or field site

Outline:

I. Resectioning is the process of plotting positions on a map from bearings taken in the field.
   A. Resectioning is useful for locating position such as with lost hikers or hunters.
   B. Resectioning can also be used to pinpoint on a topographic map the exact location of buildings, natural features, hunting or fishing spots, campsites.
   C. Prerequisites for resectioning are to have at least two identifiable points on the landscape that also appear on the map. For best results, use landmarks that are at about 90° angles to each other. Bearings taken from landmarks within 45° of each other are subject to greater error.
   D. Resectioning can be done with or without a compass.
      1. Without a compass
         a. First orient the map by inspection. That is, lay the map on the ground so the landmarks selected for reference appear in the same orientation as they appear on the landscape.
         b. With a straightedge, align the distant landmark with its symbol on the map. Draw a line across the map so when you're sighting along the line, the distant landmark appears aligned.
         c. Repeat this procedure for each landmark without disturbing the alignment of the map.
         d. The point where the lines intersect is your location. (If the lines do not intersect, the area between the lines is your approximate location.)
      2. With a compass
         a. Select landmarks as before. (The map does not need to be oriented.)

Note to instructor: Resectioning without a compass is not an accurate way to determine your location. It will provide you with a general idea as to your location.

b. Take a compass bearing from your location to the first landmark.

c. Transfer the bearing to the map by laying the compass base plate so the side touches the symbol of the landmark. Turn the entire compass (do not disturb the bearing setting) until the orienting arrow on the housing is aligned with the magnetic north lines on the map.

d. Draw a line passing through the landmark symbol using the compass base as a straightedge.

NOTE: If you have not added magnetic north lines, the compass bearing must be corrected for declination before the bearing can be drawn on the map. To correct the compass bearing, take the declination and add or subtract it from the compass bearing. *Do the opposite of what the declination rhyme says.* That is, *add easterly declinations* and *subtract westerly declinations.* This is necessary because you are converting a magnetic bearing to a true bearing—the opposite of converting a map or true bearing to a magnetic bearing.

e. Take compass bearings from the other landmarks and transfer to the map as before.

f. The area where lines intersect is your location.

Activities:

I. Pacing (This activity is necessary before attempting other exercises in this lesson.)
  A. Materials—100-foot tape, stakes or flags.
  B. Procedure:
    1. Accurately mark off 100 feet, using the tape and marker stakes or flags.
    2. Have students walk normally over the distance several times counting the number of paces they take (one pace equals *two* steps).
    3. Have students determine the length of their pace by dividing the total distance walked by the number of paces taken.

One pace = 2 steps

$$\frac{\textit{Total distance walked}}{\textit{Number of paces}} = \textit{average pace in feet}$$

$$\frac{\textit{300 feet}}{\textit{100 paces}} = \textit{3 feet per pace}$$

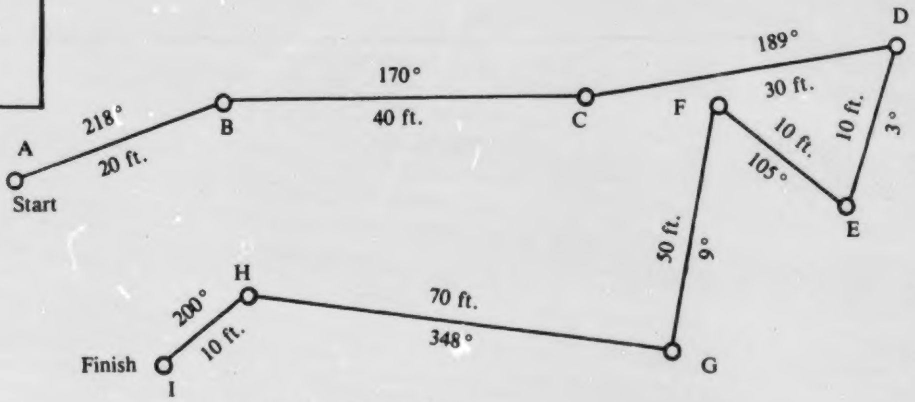
II. Bearing and Pacing
  A. Materials—compasses, course cards.
  B. Procedure:
    1. Lay out a course similar to the one illustrated. **Do not use marked control points.** Start and finish should be two different points. (You may want to conceal a marker for the finish, or walk the course yourself at the end.)
    2. Provide students with a course card giving bearing and distances for each segment. They will need to figure how many paces for each

	Bearing	Distance (ft)
A-B	218°	20
B-C	170°	40
C-D	189°	30
D-E	3°	10
E-F	105°	10
F-G	9°	50
G-H	348°	70
H-I	200°	10

Course Card

distance. Students should follow course card from designated starting point.

3. Student ending closest to finish point is the winner.



III. Making a Schoolyard Map
   A. Materials—paper, pencils, clipboards, compasses.
   B. Procedure:
      Distribute student handout, Appendix 7.

IV. Additional Activities
   If time permits, the following activities are recommended for this lesson:
   A. Pacing—pg. 50
   B. Construction of Geometric Figures with a Magnetic Compass—pg. 53.
   C. Going from Point to Point—pg. 52.
   D. Left Leg, Right Leg—pg. 50.
   E. Teaching Compass Courses—pg. 55.

No. 7

Title: Score Orienteering

Method: Field activity

Time: 50 minutes

Purpose: To combine skills of map interpretation and compass reading (This activity can be used as a culminating activity or examination for the map and compass module.)

Instructional Aids: Orienteering compasses, Orienteering maps prepared from topographic maps of the schoolyard or field site

Facilities: Schoolyard or field site

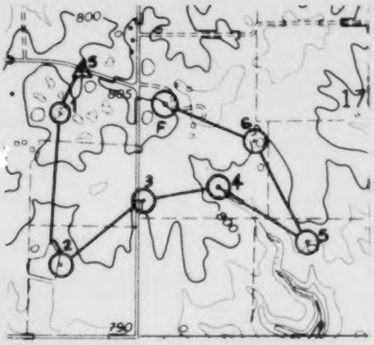
Outline: I. Orienteering

A. Orienteering is the sport of using map and compass for recreation.

B. There are many games using map and compass.

C. Competitive Orienteering is the sport in which contestants use map and compass to cover an established Orienteering course in the shortest time possible.

1. Contestants are given an Orienteering map with a route marked on it.
2. The Orienteering map is made from a topographic map of the area in which the course is located.
3. The route marked on the Orienteering map includes control points which the contestants must visit.
4. A contestant's score is based on the time taken to cover the course and the number of control points visited.



Example of a topographic map with an Orienteering route marked on it.

Activity: I. Score Orienteering Meet

A. Materials—Orienteering compasses, Orienteering maps, colored chips or tokens, score cards

B. Procedure:

1. Teacher preparation
   a. Set up control points in the field at various distances from the starting point. Control points are not in any numerical sequence and need not be found in any particular order.
   b. Mark on a map of the area the location of each control point and indicate a score or point value for reaching that marker. The control points that are easy to reach should have a low point value and the control points that are more difficult to reach should have a higher point value.
   c. At each control point, place some colored chips or tokens for the students to collect. Chips should be color-coded or marked to indicate their control point. These will be proof that the students visited the control points indicated on their score card.
   d. Prepare score sheets for each student similar to the sample on the next page.
2. Class activity
   a. Give each student a map with control points marked on it, a compass, and a score card.
   b. Students' starting time should be staggered. As each student starts and completes the course, note the time on his or her score card.
   c. Total scores and determine winners. Scores can be used as evaluations of the student's understanding of the processes involved in map and compass travel.

Name	Start Time	Score (pts.)
	Finish Time	Penalty
	Total Time	Total
Time Allowed is 30 minutes Penalty: 1 pt. for each 15 seconds late		
Description	Points	
1. The Tree Trunk	3	
3. The Doorway	5	
5. The Fence Corner	10	
17. The Shed	20	
19. The Flag Pole	25	
Totals		

Sample Score Card

Glossary

Bearing	The angular difference, measured in degrees between any point and north: given as either a magnetic (compass) bearing or a true (map) bearing.
Contour	The shape or physical relief of the landscape.
Contour Interval	The specified vertical distance between adjacent contour lines on a topographic map: given in feet in the lower map margin.
Contour Line	An imaginary line connecting all points at a given elevation. Shown on topographic maps as light brown lines.
Declination	The angular difference, measured in degrees, between true north and magnetic north from any given point.
Geographic (true) North	The true north polar axis of the earth. The point where lines of longitude (meridians) intersect.
Magnetic North	An area, approximately 1,200 miles from the true North Pole, to which a magnetized compass needle points.
Map	A reduced representation of a portion of the earth's surface.
Meridians	Imaginary lines, evenly spaced, running from the true North Pole to the true South Pole: measured in degrees east or west of the prime meridian which is assigned a value of zero degrees. Also called lines of longitude.

Orienteering	The skill and sport of using map and compass.
Parallels	Imaginary east-west lines, evenly spaced, encircling the earth and paralleling the Equator. Measured in degrees north or south of the Equator. Also called lines of latitude.
Relief	Elevations or inequalities of a land surface.
Resectioning	Determining one's location on a map from bearings taken on objects in the field.
Scale	The proportion of distances represented on a map to actual distances on the landscape. Map distance divided by map scale equals actual distance.

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Books

Barney, Terry W.; Breedlove, Michael J.; and Ludwig, Gail S. *A User's Guide to Missouri Maps*. Columbia, MO: University of Missouri, 1978.

Disley, John. *Orienteering*. Harrisburg, PA: Stackpole Books, 1973.

Gilchrist, James. *Teaching Orienteering*. Willowdale, Ontario: Orienteering Services, 1975.

Kjellstrom, Bjorn. *Be Expert With Map and Compass*. New York: Charles Scribner's Sons, 1976.

Larkin, Robert, and Schoenstein, Roger. "How to Teach Map and Compass Skills." National Science Teachers Association, 1742 Connecticut Ave., N.W., Washington, D.C. 20009.

Additional Resources

Orienteering Services, USA
P.O. Box 1604
Binghamton, NY 13902

This company has numerous teaching aids including compasses, books, games, teaching kits, and additional accessories. Several special package offers also are available with discount prices. A brochure is free; a catalog costs 50 cents.

U.S. Orienteering Federation (USOF)
P.O. Box 1039
Ballwin, MO 63011

Sources for Maps

To order topographic maps, first determine which maps are needed by consulting an index map of the state in question. Index maps of all states are available free from:

National Cartographic Information Center
507 National Center
Reston, Virginia 22092

Index maps of Missouri are available from:
Missouri Department of Natural Resources
Maps and Publications
P.O. Box 250
Rolla, Missouri 65401
314/364-1752

Once the titles of the necessary topographic maps have been obtained from the index map, the topographic maps may be ordered. For topographic maps of areas in Missouri, write the Department of Natural Resources in Rolla (address above). For topographic maps of areas outside Missouri, use the following addresses:

For areas east of the Mississippi:
Branch of Distribution
United States Geological Survey (USGS)
1200 South Eads Street
Arlington, Virginia 22202

For areas west of the Mississippi:
Branch of Distribution
United States Geological Survey (USGS)
P.O. Box 25286 Federal Center
Denver, Colorado 80225

For Canada:
Map Distribution Office
Department of Mines and Technical Surveys
Ottawa, Ontario, Canada

For county maps and aerial photographs, contact your county Agricultural Stabilization and Conservation Service (ASCS) office. Offices should be listed in the phone book under "United States Government—Agriculture Department."

Additional Activities

These are provided if time permits and you want your students to practice further their map and compass skills.

Pacing

	Number of paces to go 100 feet
First time	
Second time	
Third time	
Total	

$$\frac{\text{Total}}{3} = \text{Average number of paces to go 100 feet}$$

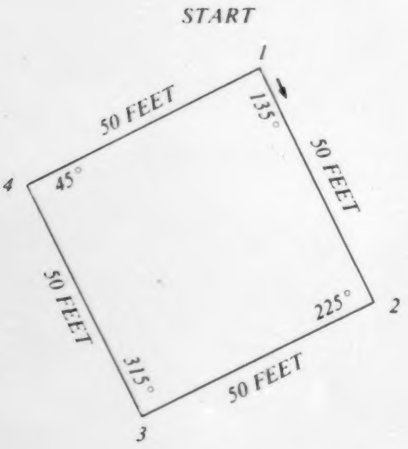
$$\frac{\text{100 feet}}{\text{Average number of paces to go 100 feet}} = \text{Length of average pace}$$

DIRECTIONS

Measure 100 feet and mark the distance with stakes. Count the number of steps it takes you to walk the 100-foot distance between the 2 stakes. Pace the distance 3 times and count every time your RIGHT foot strikes the ground. How many paces did it take you to travel 100 feet? (Be sure to emphasize to students a natural walk rather than a gait or stride.)

Determine the length of your pace: Fill out the table to the left and compute the average length of your pace. Round off your average pace to the nearest 1/2 foot. In other words, 4 feet, 4 inches equals 4½ feet, and 4 feet, 2 inches equals 4 feet, etc.

Running a Square



DIRECTIONS

Find a spot in the area where there are no obstacles (fences, trees, etc.) for a distance of 50 feet in any direction. Put a can lid stake into the ground to mark your position. Remember your number.

1. Determine the number of paces required in order to go 50 feet. (If your pace is 5 feet, then 50 ÷ 5 = 10 paces, etc.) How many of your paces are required to go 50 feet? ____
2. Set any bearing you wish on your compass.
3. Stand next to your can lid stake and travel 50 feet in the direction indicated by your compass. Be accurate.
4. At the end of 50 feet, STOP. Add 90° to the reading on your compass and go 50 feet in the new direction.
5. Complete the legs of a square by adding 90° to each compass reading after you have traveled 50 feet. (See illustration.)
6. If you have not made too great an error, you should return to your starting point. How far were you from your starting point when you finished? ____
7. When you have successfully completed the square with 50-foot legs, complete another square with 100-foot legs. How far were you from your starting point when you finished? ____

Left Leg, Right Leg

Most people, when lost, will travel in a circle the radius of which is seldom over one-half mile. Thus, if you ever get lost, you will probably be within one-half mile of your starting point. Moreover, the direction of the circle (right or left) depends on the terrain and the length of each leg. Did you know that nearly everyone has one leg which is slightly longer than the other (no kidding)? On flat ground, a lost person would probably veer (turn) away from his longest leg. So, if you circle to the right on level ground, your left leg may be slightly longer than your right. This exercise should prove conclusively that you can't travel in a straight line without using a compass.

DIRECTIONS

1. Work in pairs.
2. Find a tree or other obstacle and place your back against it. Sight towards an object on the horizon at least 100 yards away.
3. Face directly towards the object on the horizon you identified. Without disturbing the direction of your body, put on the blindfold and begin walking towards the object. (Your partner should walk about 5 feet away and watch you to make sure you don't walk into any obstacles. Your partner should not influence your direction by talking to you or touching you. He should tell you to stop only if you are in danger of running into something.)
4. When you have walked about 100 yards, remove the blindfold and open your eyes. Sight back to your starting point. Did you go in a straight line, or did you circle? ________________ Do you think one leg is longer than the other?_______ Which one?_______________

Magnetic Influence

DIRECTIONS

Place your compass near a steel or iron object such as a sign post or fire hydrant. How does the steel object affect the compass needle? ______________________________
_____________ Place the compass near an aluminum pole.
What happens? ___________________________________
Can you use a compass in an aluminum canoe? _________
____
____

Three-Legged Traverse

In this activity students will walk a three-legged compass course. They will begin and end at the same point.

DIRECTIONS

1. Place a coin between your feet at least 50 feet away from the nearest obstacle.
2. Set any bearing on the compass and walk 50 feet in that direction. STOP.
3. Add 120° to the first compass bearing. Walk 50 feet in the direction indicated on the compass. STOP.
4. Add 120° to the second compass bearing. Walk 50 feet in the direction indicated on the compass. STOP.
5. If correctly done, you should have returned to your starting point.

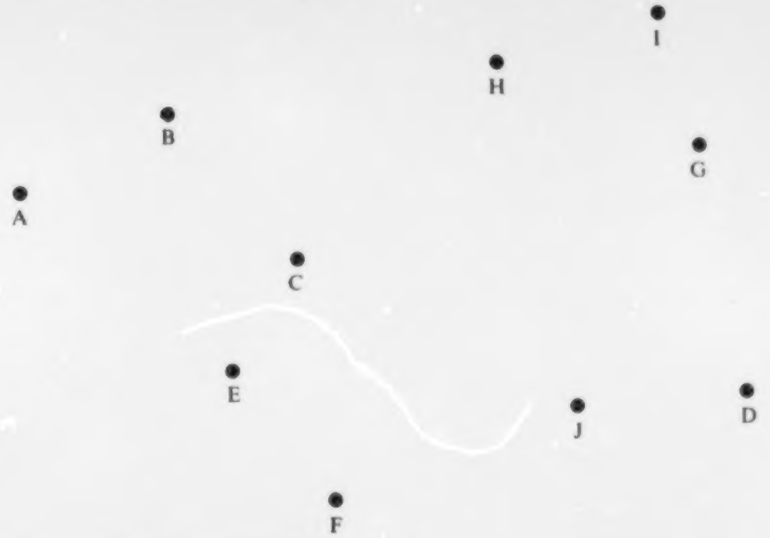
NOTE: Students sometimes get confused when they have to add 120° to a bearing of over 240°. Example: If last bearing was 320°, then 320° + 120° = 440°, 440° - 360° = 80°, which should be set on the compass.

Going From Point to Point

DIRECTIONS

Use your compass to determine the *bearing* and *distance* from point to point. Start at point A and proceed in alphabetical order. Place your answers in the table given. When you have finished, check your answers with your teacher. Use a scale of 1 inch on the map = 10 feet on the ground.

POINT	BEARING	DISTANCE
A--B		
B--C		
C--D		
D--E		
E--F		
F--G		
G--H		
H--I		
I--J		



Geometric Figures With a Magnetic Compass

OBJECTIVES

To provide experience with the magnetic compass. To improve concepts of simple geometric figures.

EQUIPMENT

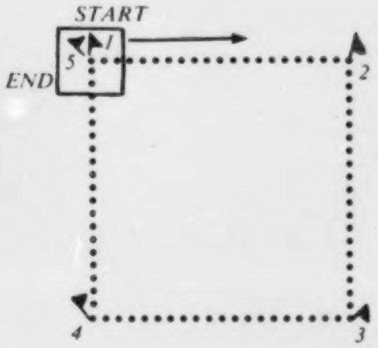
A compass and 6 or 7 colored flags or markers for each student or pair of students. An open field or area is needed.

PREPARATION

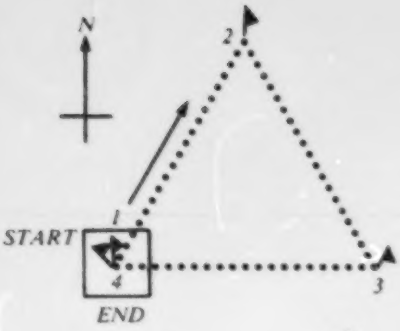
Provide instruction about azimuths (degrees) and the use of a compass (this exercise provides experience following such instruction). It helps if several colors of markers are used; all markers of a particular student should be the same color.

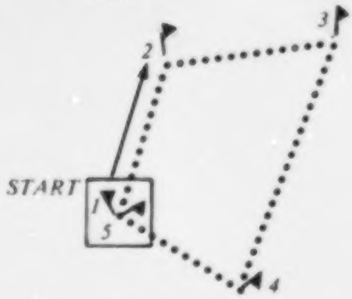
ACTIVITY

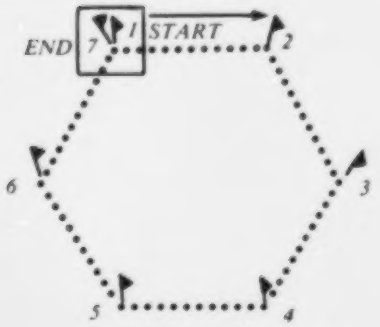
Position students with several steps between each person. **Do not** inform them of the types of figures they are constructing.



1. Constructing a square:
    a. Place first marker at feet.
    b. Walk 10 steps at 90° and place second marker.
    c. Walk 10 steps at 180° and place the third marker.
    d. Walk 10 steps at 270° and place the fourth marker.
    e. Walk 10 steps at 360° and place the fifth marker.
    Step back to look at the area enclosed. Measure the distance between the first and fifth markers. Review the directions. What type of figure should have resulted? Analyze errors. (Markers 1 and 5 should be at the same point.)







2. Constructing an equilateral triangle:
   a. Place first marker at feet.
   b. Walk 10 steps at 30° and place second marker.
   c. Walk 10 steps at 150° and place third marker.
   d. Walk 10 steps at 270° and place fourth marker.
   Measure the distance between the first and fourth markers. Review directions; discuss errors. Analyze figures as to length of sides, angles, etc.
3. Constructing a trapezoid:
   a. Place first marker at feet.
   b. Walk 10 steps at 30° and place second marker.
   c. Walk 10 steps at 75° and place third marker.
   d. Walk 17 steps at 210° and place fourth marker.
   e. Walk 7 steps at 300° and place fifth marker.
   Analyze—measure error—discuss figures, relationship of sides, etc., as in the case of the square and triangle.
4. Constructing a hexagon:
   a. Place first marker at feet.
   b. Walk 10 steps at 90° and place second marker.
   c. Walk 10 steps at 150° and place third marker.
   d. Walk 10 steps at 210° and place fourth marker.
   e. Walk 10 steps at 270° and place fifth marker.
   f. Walk 10 steps at 330° and place sixth marker.
   g. Walk 10 steps at 30° and place seventh marker.
   Analyze as before.

FOLLOW-UP INDOORS

Construct the same figures to scale on paper. Use protractors instead of magnetic compasses and the same directions given outdoors. Orient properly with a north—south line on the paper. (Is this a map-making activity?)

Construction of Geometric Figures With a Magnetic Compass

OBJECTIVES

To apply and improve compass skills. To clarify concepts of distance, direction, geometric figures, perimeter, area, and other geometric relationships.

EQUIPMENT

The following for each team of three or four students:

Six stakes (labeled A, B, C, D, E, F)
One or more compasses
Plenty of string
Open area or field

PREPARATION

Students should be familiar with the compass, how to use it to measure sizes of angles and to lay out angles of given size, and the length of their step or pace.

CONSTRUCTION

The Square. Place Stake A at a convenient point and let it be the NW corner of the square. Make a 20-step line directly SOUTH from this point. This makes the WEST boundary. Drive Stake B at the SW corner, Stake C at the SE corner, and Stake D at the NE corner.

Angle Bisectors. With your magnetic compass bisect the angle at each of the four corners. Do your bisectors intersect at one point? Should they? Drive Stake E at this point.

Bisector of Side BA. Drive Stake F on the midpoint of Side BA. This point should be west of Stake E. Is it?

Fencing. Connect all points possible using strings (omit the string between F and C, and F and D).

MEASUREMENTS

You lack standard measures (or units) to find the distance between points in your construction; hence, decide on some item as a standard unit (suggestions: step, length of stick, etc.). What did you select? ___________

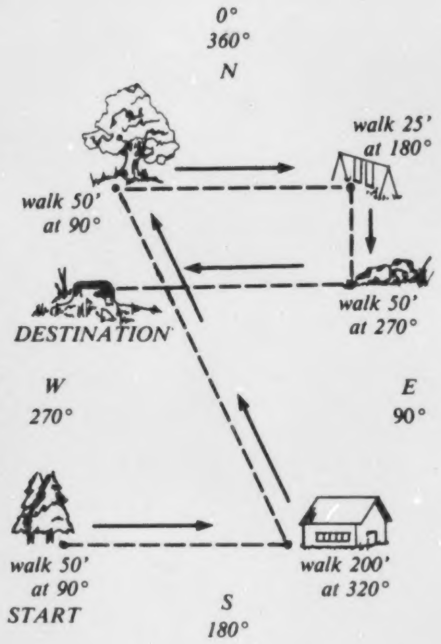
1. With your unit, measure the distance between these points:
    A - C _____
    A - B _____
    C - D _____
    E - A _____
    E - C _____
    F - A _____
    E - F _____
    B - D _____
    B - C _____
    D - C _____
    E - B _____
    E - D _____
    F - B _____
2. Count the similar angles in your construction. How many right angles (90°)? _____ 45° angles? _____
3. Since you measured the distance between each pair of stakes and the angles of the triangles in your construction, you can answer these questions about the areas and perimeters:
    a. What is the area in your units of the square ABCD? ____________
    b. Compare the sum of the areas of the triangles ABC and BDC with the area of the square ABCD. What is the ratio? _______
    c. Compare the area of triangle AED or CED and the area of the square ABCD. _______
    d. What is the perimeter of ABCD _____, ABD _____, AED _____, AEF _____?
4. Similar and congruent triangles:
    a. Locate four triangles that are alike (congruent). They are _____, _____, _____, and _____.
    b. Indicate at least three pairs of congruent triangles:
        _____ and _____,
        _____ and _____,
        _____ and _____.
    c. How may isosceles triangles (having two equal sides and angles) can you find? ____________
5. Locate two trapezoids. How many sides and corners does each have? ______________________. Indicate the corners of each: _____, _____.
6. What generalizations can you draw about the bisectors of the angles of a square (by examining your construction)?
    a. ____
    b. ____
    c. ____

7. What is the direction (in degrees) from A to B ______, C to A ______, E to F ______, A to C ______, F to E ______?

SUMMARY

Discuss with other members of your team the relationships you have seen, some of the concepts you have developed and the advantages and disadvantages of approaching this problem in this way as compared to working with a pencil and paper construction.

Constructing Teaching Compass Courses



Teaching compass courses may be used almost any place (school sites, campsites, etc.) to develop concepts and understandings. Their essential features include:

1. Teaching stations and/or locations.
2. Comments, questions, and activities at each station relative to what the students are to observe, measure, do, or accomplish.
3. Directions leading students from station to station.

Teaching compass courses may have many purposes. These include:

1. To apply and develop compass skills.
2. To orient students to an area or to serve as an awareness exercise.
3. To provide identification experiences (trees, rocks, buildings, etc.).
4. To develop a concept (ecology, geology, similarities and differences, etc.).
5. To point out individual specimens or situations leading to generalizations.

Good compass courses require considerable work and time to construct. Hence, several leaders may wish to plan and develop an activity jointly.

1. Clearly define the educational purposes and objectives.
2. Select the stations and develop activities, observations, and questions applicable to each.
3. Determine the sequence of the stations in the compass course.
4. Develop directions to lead students from station to station:
    a. Measure the distances.
    b. Determine the degrees from station to station. Check and recheck!
    c. Provide hints to tell students if they are near to where they ought to be. (Examples: At your right is a chimney. Directly west of you is a swing.)
5. A course may be designed to provide directions for completing the entire course at the beginning or students may discover directions as they proceed from station to station.
6. Prepare the students beforehand (they may work individually or in small groups):
    a. They should know the reason for the compass course.

   b. They should know their step length.
   c. They should know how to convert feet or yards to steps. (Here is an application of ratio and proportion.)
   d. They should know how to use a magnetic compass.
   e. They need pencils, paper, compasses, and other apparatus.
7. Follow up indoors.

Fifteen Degrees

This exercise ties together the compass, watches, astronomy, sextants, sundials, and the calendar.

Many kinds of activities can stem from the earth's rotation creating a thread running through astronomy, compass work, and time. They lead to an understanding of the calendar and help us understand the apparent movement of the stars, planets, and the moon. Students can then make sundials, understand the sextant, use a compass to tell time, and use a watch to find directions.

BASIC IDEA

The earth revolves around the sun approximately once every 365 days. The earth rotates on its axis once every 24 hours. Since there are 360° in a circle, the earth rotates approximately 15° each hour.

ACTIVITIES

1. Select a tall central point such as a flagpole or other tall post.
2. Tie one end of a 15-foot string to the pole.
3. At each hour (from 6 a.m. to 6 p.m.), extend string along shadow and at end of string pound a stake into the ground and mark on the stake the time of day.
4. Make compass readings for the shadow (caused by the sun) corresponding to the stakes set for each hour of the day (sunrise to sunset).
5. Select other compass readings and determine the time when the shadow falls at these points.

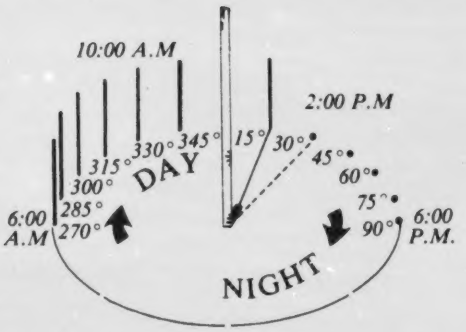
QUESTIONS

Questions similar to these may be helpful in observing, recording, and analyzing data:

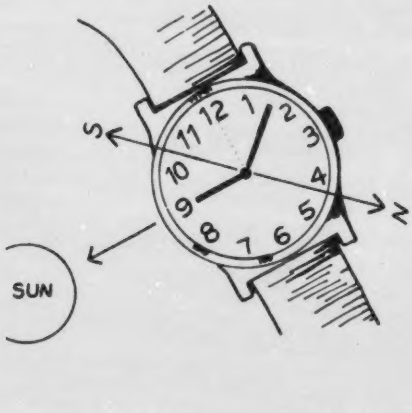
1. Through how many degrees does the earth rotate in one hour?
2. How do the daylight hours for winter and summer compare? (Actual observer data can be compared to data from calendars.)
3. How can a watch be used as a compass on a sunny day between 6 a.m. and 6 p.m.?

   One method is to point the hour hand at the sun. Bisect the angle between the hour hand and 12. That should be south. If your watch is not set on standard time, reset it for this activity.

   NOTE: This method is not very accurate if the sun is high.
4. Have students diagram the apparent motion of the sun and determine if the earth rotates in a clockwise or counterclockwise manner.



Note to instructor: Starting and ending times will depend on season of year and geographic location.



Teaching students how to use a watch as a compass is good training for emergency situations.

5. Why do the sun, planets, stars, and moon appear to move around the earth?
6. Observe the night sky at various times—both in person and using time-lapse photography. What star does not appear to move? (Polaris) Why is this the case? Why is this useful? Plot the course of the Big Dipper around Polaris (North Star).
7. What is a "winter sky?" What is a "summer sky?" Have students observe the sky at 5 p.m., 8 p.m., and at other times on a given night. Must we wait until winter to see a winter sky?
8. How does the path of a planet differ from that of the stars? Continue your observations over a period of weeks or months.
9. If you fix a time-lapse camera on Polaris for about two hours, what would your picture look like? Make a drawing.
10. Investigate to find how a sextant works. Could you use a clinometer or make one from a ruler, protractor, piece of string, and sighting level to mark and predict the movement of the stars around Polaris?
11. Make a sundial.
12. Work out a way to tell time by the stars.

Appendix 1—Map Legend

CONTROL DATA (Black)

Horizontal control station

Vertical control: station; spot elevation

BOUNDARIES (Black)

National

State or territorial

County or equivalent

Civil township or equivalent

Incorporated city or equivalent

Park, reservation, or monument

Small park

LAND SURVEY SYSTEMS (Red)

U.S. Public Land Survey System:

- Township or range line
- Section line

Other land surveys:

- Township or range line
- Section line

Fence line

ROADS AND RELATED FEATURES (Black)

Primary highway (Red)

Secondary highway (Red)

Light duty road

Unimproved road

Trail

Bridge

Tunnel

BUILDINGS AND RELATED FEATURES (Black)

Dwelling or place of employment: small; large

School; church

Barn, warehouse, etc.: small; large

Well (other than water)

Water tank: small; large

Other tank: small; large

Gaging station

Campground; picnic area

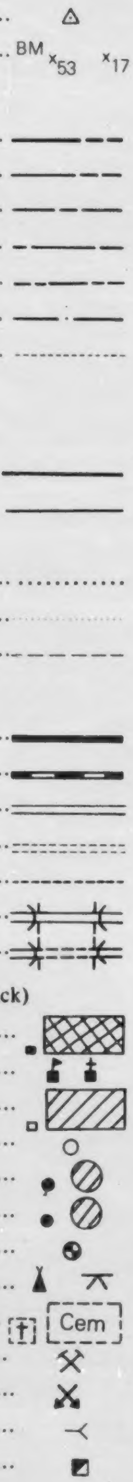
Cemetery: small; large

Quarry or open pit mine

Gravel, sand, clay or borrow pit

Mine tunnel or cave entrance

Mine shaft



RAILROADS (Black)

Standard gauge single track

Standard gauge multiple track

Abandoned

TRANSMISSION LINES (Black)

Power transmission line: pole; tower

Telephone or telegraph line

CONTOURS (Brown)

Intermediate

Index

Supplementary

Depression

Cut; fill

SURFACE FEATURES (Brown)

Levee

Sand or mud areas, dunes, or shifting sand

Tailings Pond

Tailings

Mine dump

VEGETATION (Green)

Woods

Scrub

Orchard

Vineyard

Wooded marsh or swamp

WATER AREAS (Blue)

Intermittent stream

Intermittent river

Disappearing stream

Perennial stream

Perennial river

Small falls; small rapids

Large falls; large rapids

Dam with lock

Intermittent lake or pond

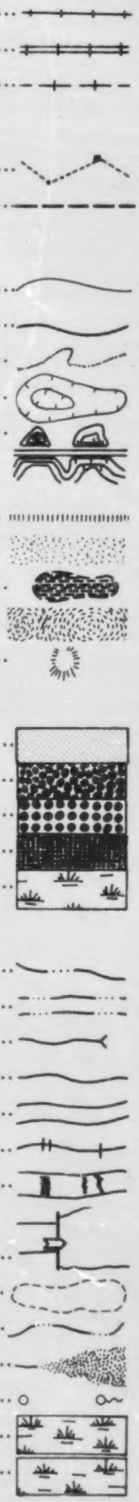
Narrow wash

Wide wash

Water well; spring or seep

Marsh or swamp

Submerged marsh or swamp

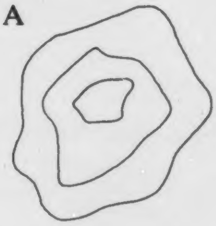


Appendix 2—Matching Contour Lines and Verbal Descriptions

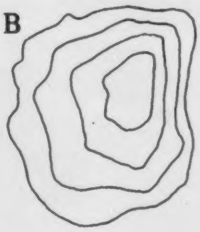
Purpose:	To aid students in understanding the concept of contour lines.
Materials Needed:	Contour Line Worksheet
Procedure:	1. A series of contour line diagrams are drawn on a worksheet accompanied with a set of verbal descriptions. 2. The object of the exercise is to match the verbal description with the proper contour diagram.
Additional Activity:	Students could draw their own diagrams and trade with other students.

Sample Worksheet

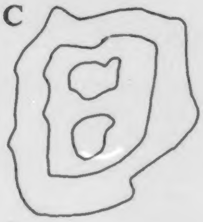
A



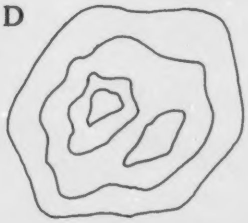
B



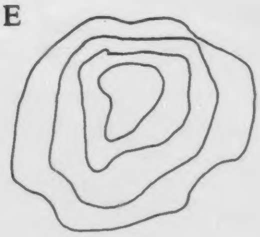
C



D



E



1. Has a steep northern slope
2. Has gentle uniform slopes
3. Is a round hill with two summits
4. Has two summits—the western one is higher
5. Has a steep eastern side

Answers 1. E 2. A 3. C 4. D 5. B

Appendix 3—Pairing Profiles and Contour Lines

Purpose: To aid in understanding the concept of profiles in relationship to contour diagrams.

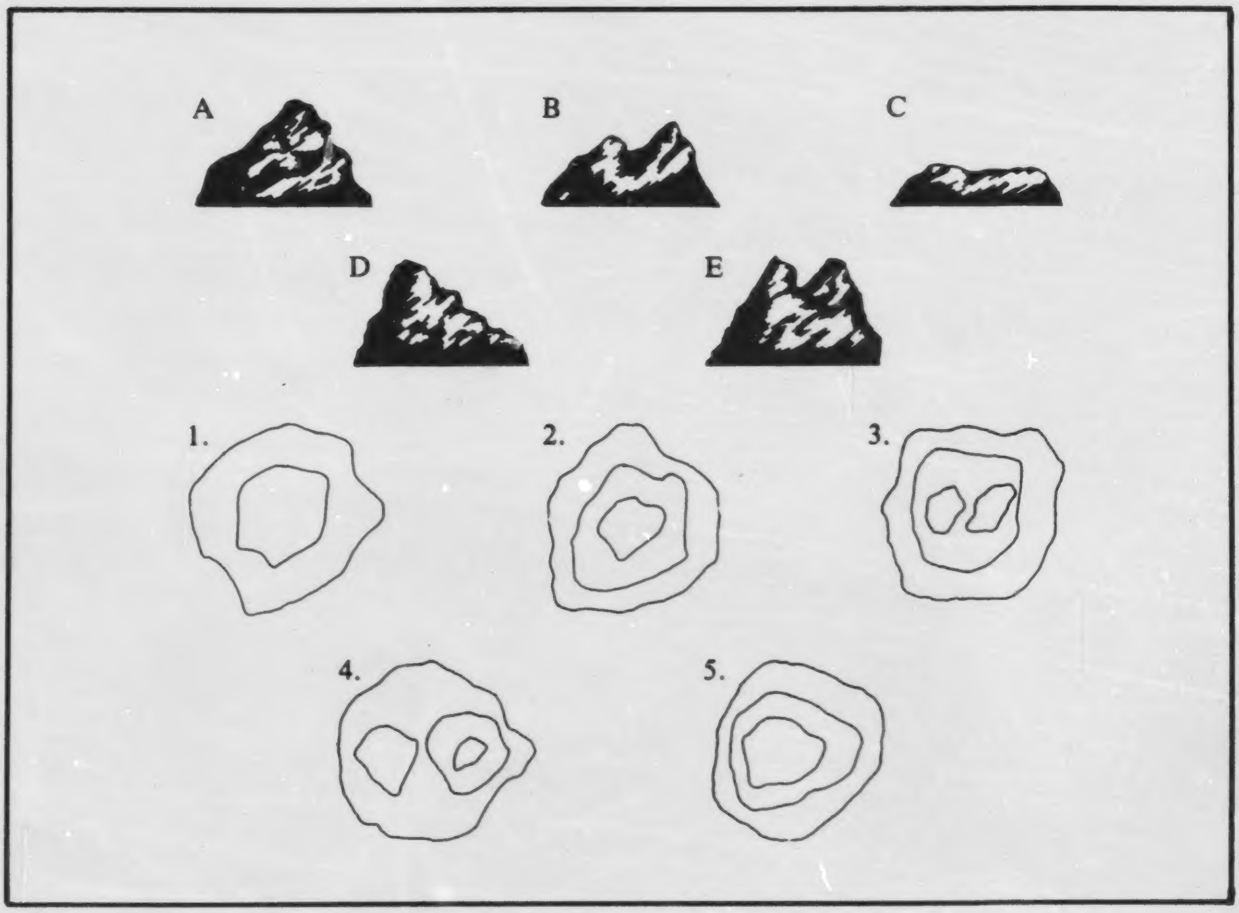
Materials Needed: Profile Worksheet

Procedure:

1. A series of cross-section profiles are drawn on a worksheet with a set of contour line diagrams.
2. The object of the exercise is to match the contour diagrams with the proper profiles.

This activity can be as simple or as complex as desired. Students can develop their own cross-section profiles and contour diagrams.

Sample Worksheet



Answers 1. C 2. A 3. E 4. B 5. D

Appendix 4—Introduction to Topographic Maps

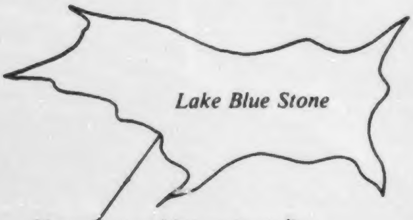
by John H. Siebert

Editor's note: This instructional program was written by John Seibert in 1975 as the final project for a graduate course at Central Missouri State University. The program was pre-tested and analysis of the post test confirmed that the intended objectives were taught. John is currently a free-lance multi-image programmer in Independence, Missouri. He graduated from CMSU in 1971 with a bachelor of science degree in education, in 1972 with a master of science degree in education, and in 1975 with an education specialist in higher education. He enjoys white water canoeing, camping, and deer hunting in the Ozarks.

Instructions

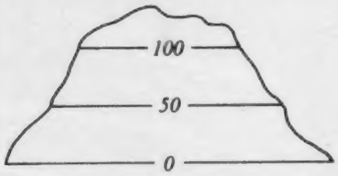
This instructional package was designed as an introduction to topographic maps for students who have had no previous instruction concerning topographic maps. Do not feel rushed. Take your time and carefully study each exercise. Particularly look at the labeled examples. At the end of the material there is an exercise in which you will be asked to label 4 common landforms on a topographic map—hilltops, cliffs, depressions, and stream beds.

Contour Lines

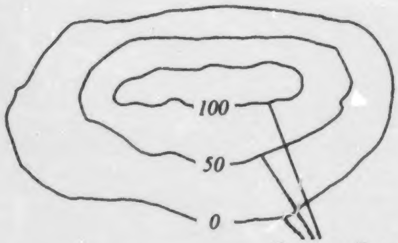


Shore line and/or contour line

A contour line is a line drawn on a map that passes through all adjacent points having the same elevation above sea level. Since a lake's surface is flat, it is all at the same elevation. If its shore line could be seen from the air it would look like a contour line.



If we could paint elevation lines on a hill and then view that same hill from the side, it might look something like this:

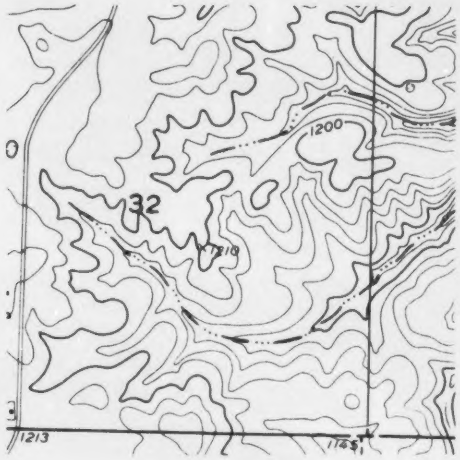


Contour lines

Then if we flew over the same hill in an airplane and looked down it might look something like this:

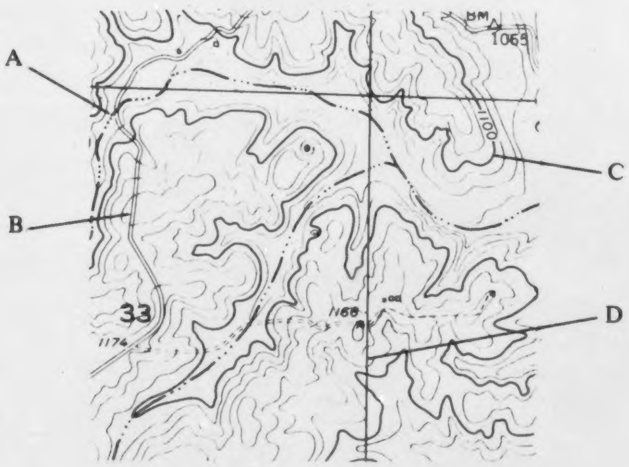
Exercises

1. Read the following information and then DRAW arrows to TWO different contour lines on the topographic map provided. Contour lines are lines drawn on maps which pass through all adjacent points having the same elevation above sea level.



2. Which arrow on this topographic map is pointing to a contour line?

A. ____ B. ____ C. ____ D. ____

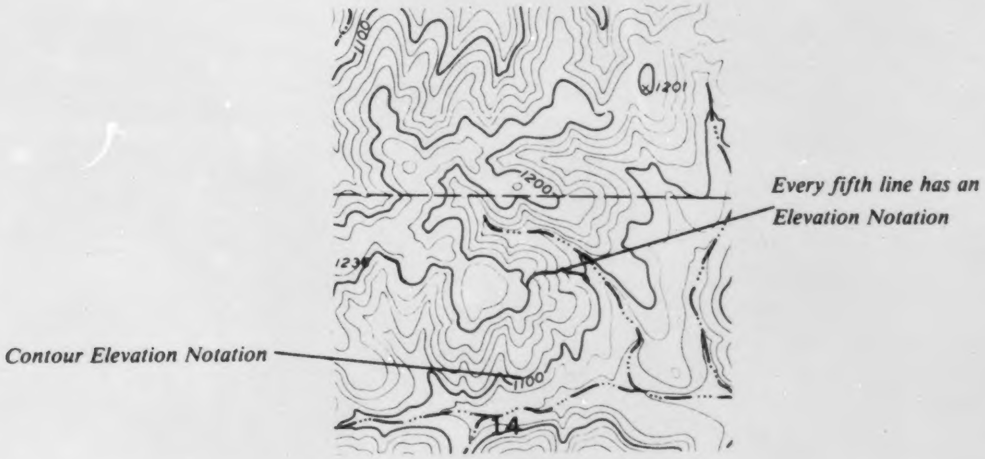


Contour Elevation Notation

A contour elevation notation tells the elevation above sea level of all the points through which a contour line passes.

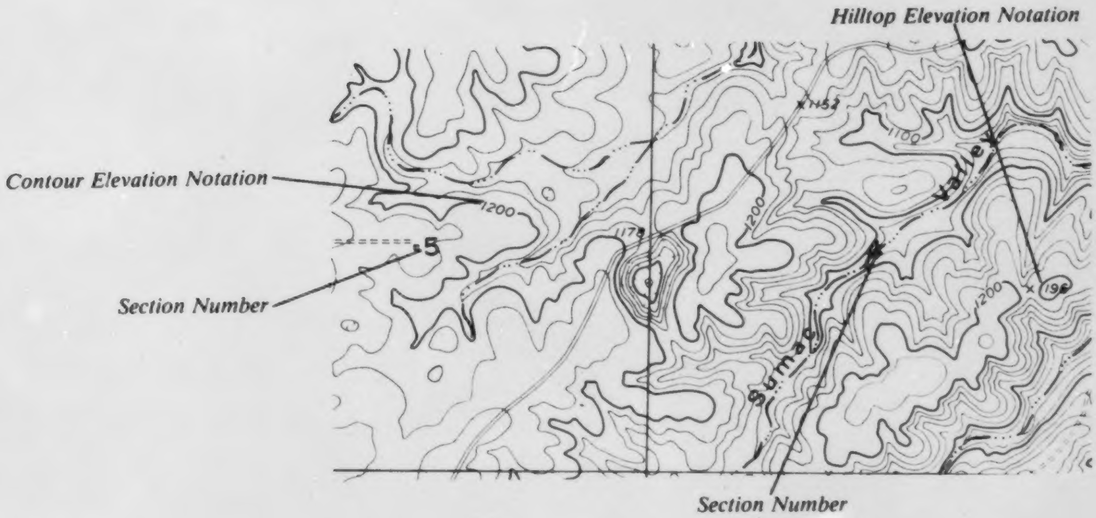
A contour elevation notation is usually placed in a gap in the contour line.

Contour elevation notations are NOT usually on every contour line but every fourth or fifth one.


1100
1201
1200
Every fifth line has an Elevation Notation
1234
Contour Elevation Notation
1100
14

The following two items are numbers which are printed on topographic maps but are NOT contour elevation notations.

1. A number beside an (X) indicates the elevation of either the top of a hill or the bottom of a depression.
2. A number which is printed larger, is from 1 to 36, and is in the center of a square is a section number.



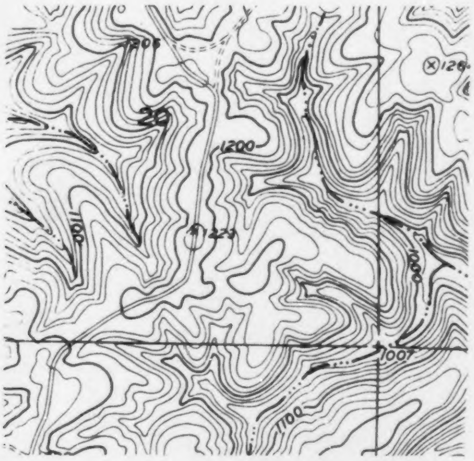
Exercises

1. Circle a contour elevation notation on this map after reading the following statements:

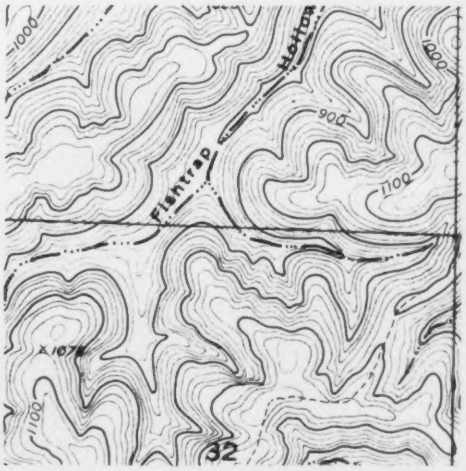
a. A contour elevation notation tells the elevation above sea level of all the points through which a contour line passes.

b. A contour elevation notation is usually placed in a gap in the contour line.

c. Contour elevation notations are not usually on every contour line, but every fourth or fifth one.



2. Draw arrows to 2 contour elevation notations on this topographic map.



Contour Interval

The contour interval of a topographic map is the vertical distance in feet represented by the space between contour lines. If elevation notations were placed on each contour line, simple subtraction would suffice to determine the contour interval; however, elevation notations are usually on every fourth or fifth line.

To calculate contour interval, pick 2 adjacent contour elevation notations and subtract the low one from the high one, then divide that result by the total number of contour lines involved minus 1.

NOTE: Contour elevation notations are the numbers used, **not** hilltop and depression elevation notations and section numbers.

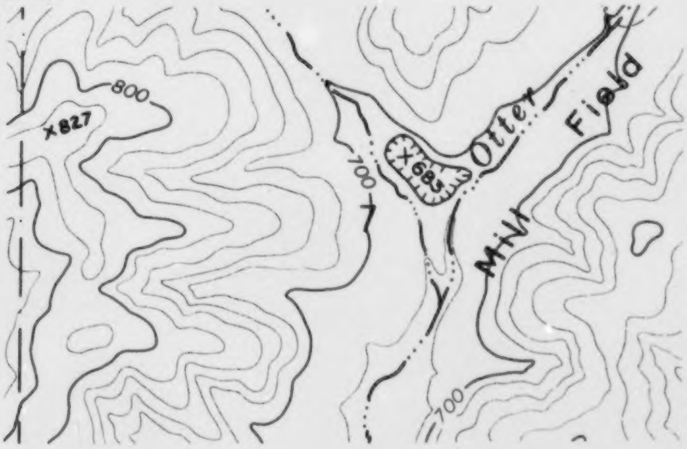
If the above procedure was written in the format of a formula it would look like this:

$$CI = \frac{H - L}{CL - 1}$$

Where: CI = contour interval
H = high elevation
L = low elevation
CL = total contour lines

Remember too that the contour interval for a map is printed in the bottom margin of each map.

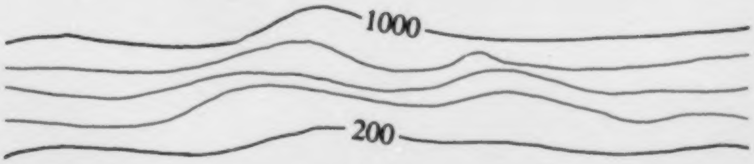
On this topographic map the formula would work as follows:



$$CI = \frac{H - L}{CL - 1} = CI = \frac{800 - 700}{6 - 1} = CI = \frac{100}{5} = CI = 20$$

Exercises

1. Complete the calculation of this contour interval:



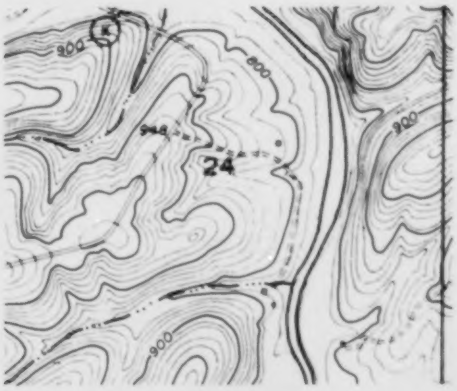
$$CI = \frac{H - L}{CL - 1} = CI = \frac{1000 - 200}{5 - 1} = CI = \frac{800}{4} = CI = \_\_\_\_\_ \text{ft.}$$

2. Complete this calculation, given the adjacent elevation notations and the total number of contour lines involved.

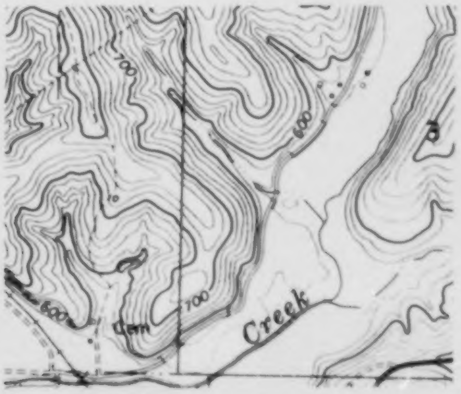
$$CI = \frac{H - L}{CL - 1} = CI = \frac{200 - 175}{6 - 1} = CI = \frac{\qquad}{\qquad} =$$

3. Given the following section of a map and the formula for the determination of contour interval, complete the calculation of the contour interval.

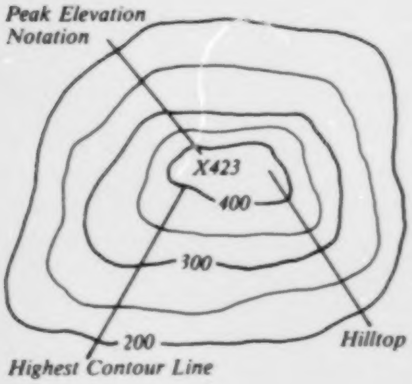
$$CI = \frac{H - L}{CL - 1}$$



4. Calculate the contour interval for this section of topographic map without referring to past exercises:



Hilltops



A hilltop is represented by a closed contour line which has no other contour lines inside it and has a higher elevation than the surrounding contour lines.

Study the example. Note:

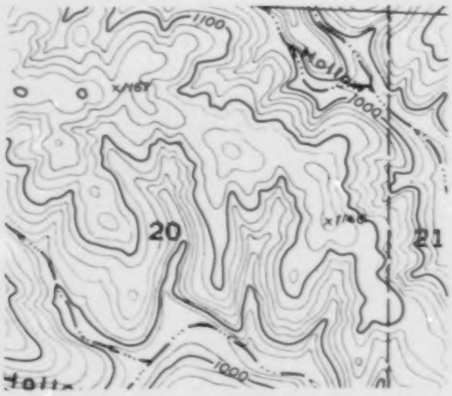
1. The hilltop is a closed contour line.

2. The hilltop has no other contour lines in it. However, there is an elevation notation marked with an (X) for the peak.

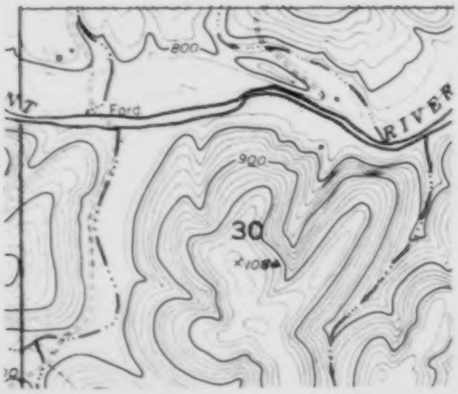
3. The hilltop contour line has a higher elevation than all the surrounding contour lines.

Exercises

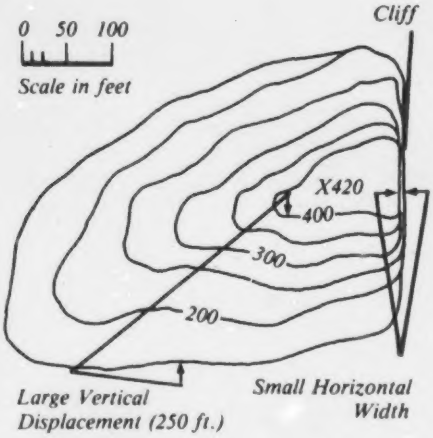
1. After reading the following information about hilltops, use an arrow to label a hilltop on the example topographic map.
   a. Hilltops are closed contour lines.
   b. Hilltops have no other contour lines inside them.
   c. Hilltops have a higher elevation than all the surrounding contour lines.



2. Using an arrow, label a hilltop on this map.



Cliffs



A cliff is indicated by a group of contour lines representing a large vertical displacement, which converge into one or very few contour lines that are confined to a very small horizontal space.

Study this example of a cliff.

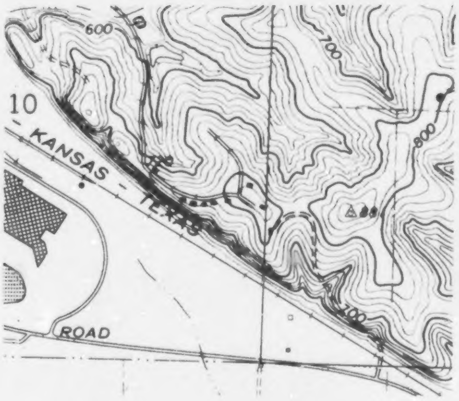
1. The cliff is made up of contour lines with elevations of 150 ft. to 400 ft. which makes it a 250 ft. drop.

2. Six contour lines meet to form the cliff, but it is so steep that it appears to have only 3 lines at the dropoff. That means in places there is a vertical drop of over 50 ft.

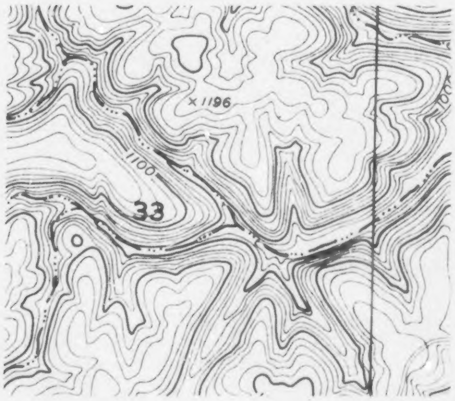
3. The cliff is 250 ft. tall or closely equal to a 25-story building, however, its horizontal width is only about 12.5 ft.

Exercises

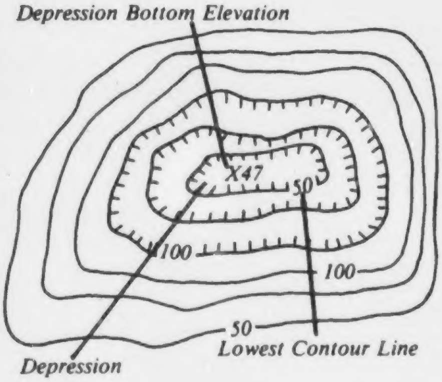
1. After reading these characteristics of cliffs, draw an arrow to a cliff on this map.
   a. Cliffs are made up of contour lines which represent a large vertical displacement.
   b. Cliffs are made up of contour lines which converge into very few or even one contour line.
   c. Cliffs are confined to a very small horizontal space.



2. Using an arrow, label a cliff on this map.



Depressions

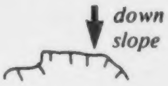


A depression has no drainage outlet and is represented by closed contour lines with hachures (short lines) pointing in the direction of slope. The centermost contour line has an elevation lower than all the surrounding contour lines.

Study the depression in this example.

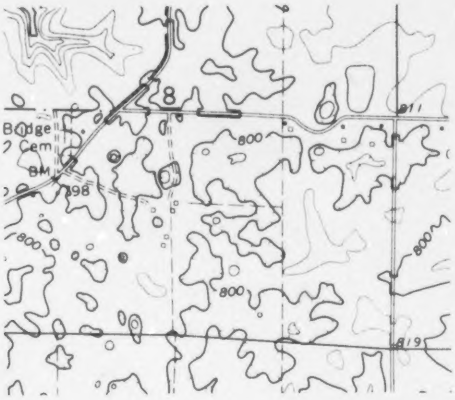
1. A depression has no drainage outlet.
2. A depression has contour lines which have hachures (short lines) pointing in the direction of slope.
3. A depression has a contour line at the deepest point which has an elevation lower than all the surrounding contour lines.

Contour Line With Hachures

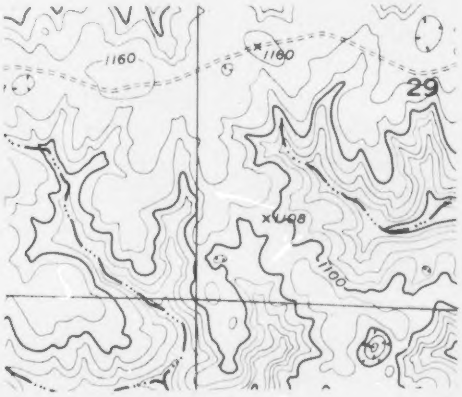


Exercises

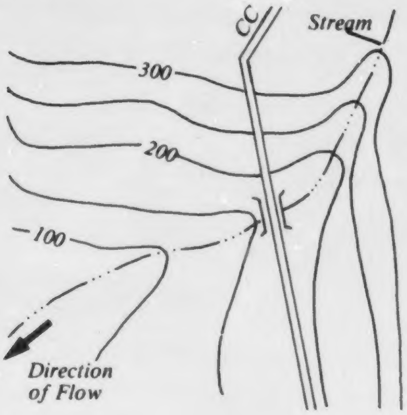
1. Using an arrow, label a depression on this map considering all these factors:
   - a. A depression has no drainage outlet.
   - b. A depression has closed contour lines with hachures pointing in the direction of slope.
   - c. A depression's centermost line has a lower elevation than all the surrounding contour lines.



2. Using an arrow, label a depression on this map.



Stream Beds



A stream bed on a topographic map is represented by contour lines which bend upstream and cross the stream at right angles.

Because of the elevation difference between the bank of a stream and the stream bottom, contour lines always bend upstream (up the slope) and at right angles to the flow.

Study the example.

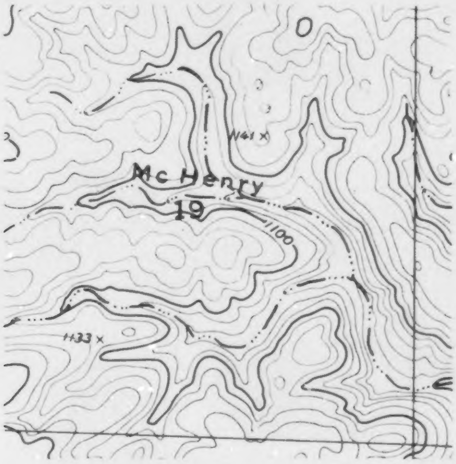
1. In a stream bed contour lines will bend upstream before crossing the stream.

2. In a stream bed contour lines always cross the stream at right angles to the direction of flow. Anything which crosses the stream at a diagonal must be manmade.

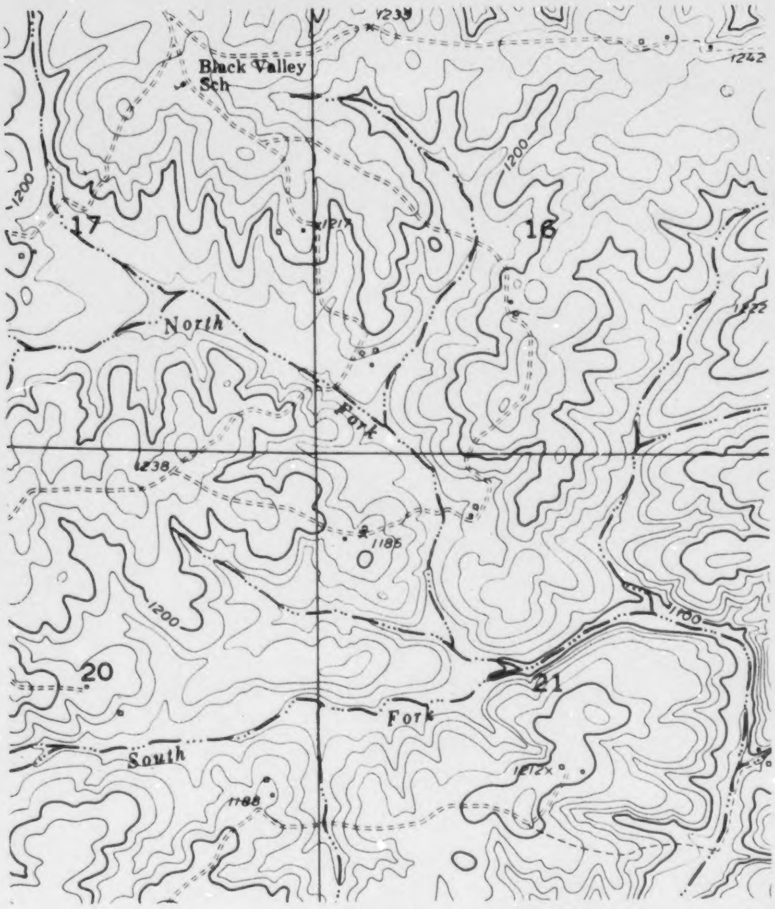
Exercises

1. On this map, label a stream bed by encircling it and pointing to it with an arrow. First take into consideration the following:

   a. Stream beds have contour lines which bend upstream.
   b. Stream beds have contour lines which cross the stream at right angles.
   c. A stream bed may be present even if a stream symbol is not present.



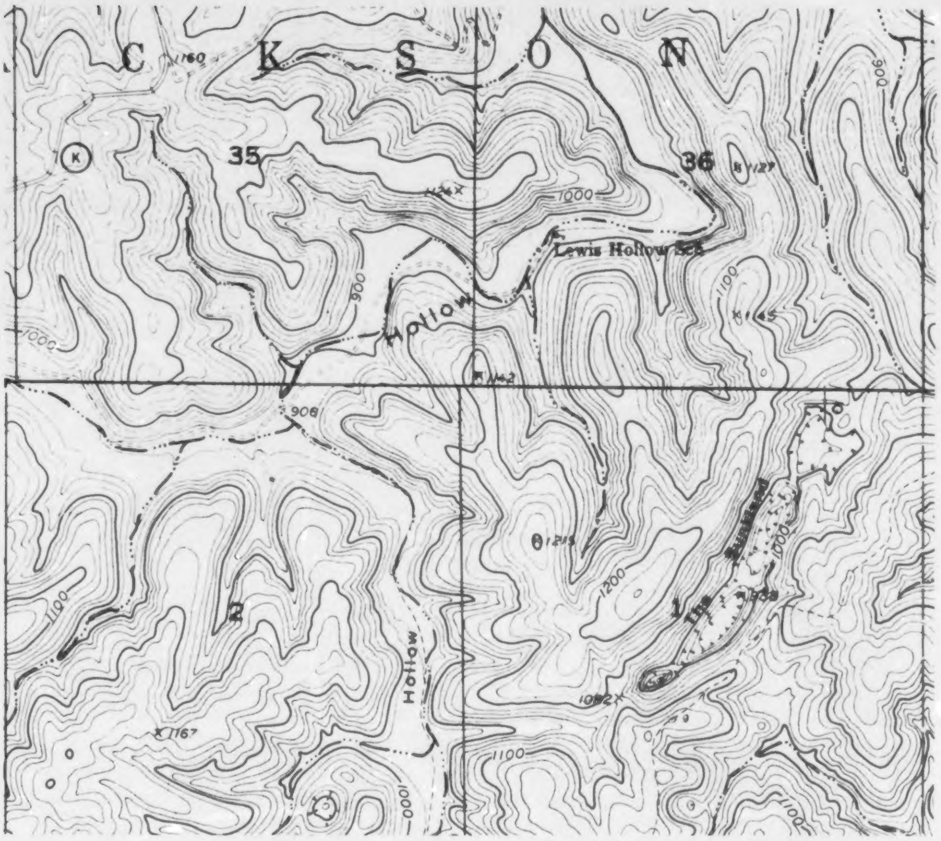
2. Label 2 stream beds on this map by encircling and drawing arrows to them.



Do this exercise without looking back to any of the past exercises.

Using arrows, label 2 of *each* of the following landforms on the map below:

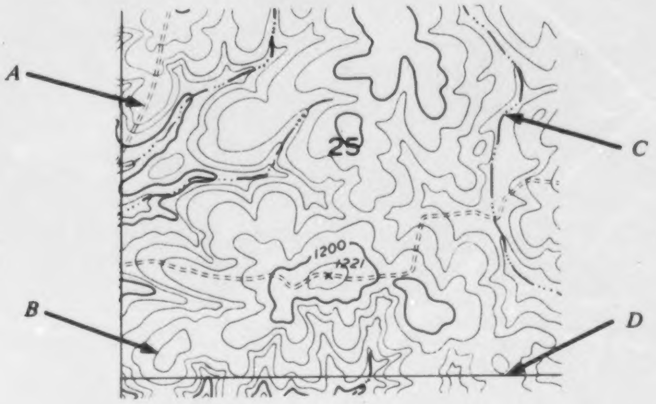
1. Hilltops
2. Cliffs
3. Depressions
4. Stream Beds



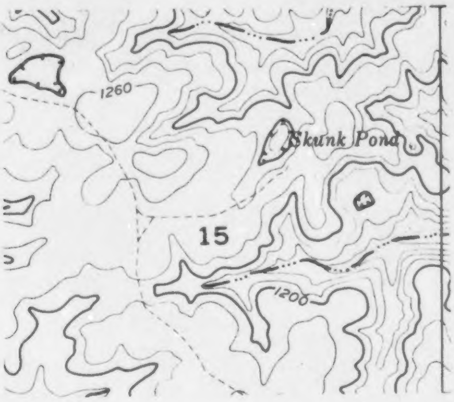
Evaluation Exercise

Do this without looking back to any part of the program.

1. Which arrow on this map is pointing to a contour line? ________



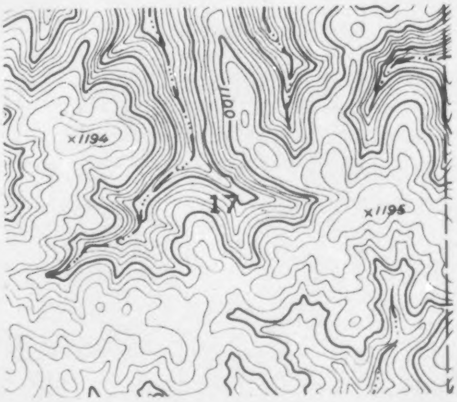
2. On this map draw arrows to 2 depressions.



3. A number which tells the altitude of a contour line above sea level is a/an

____.

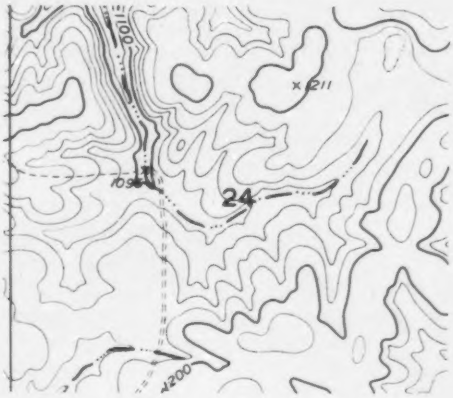
4. On this map draw arrows pointing to 2 hilltops.



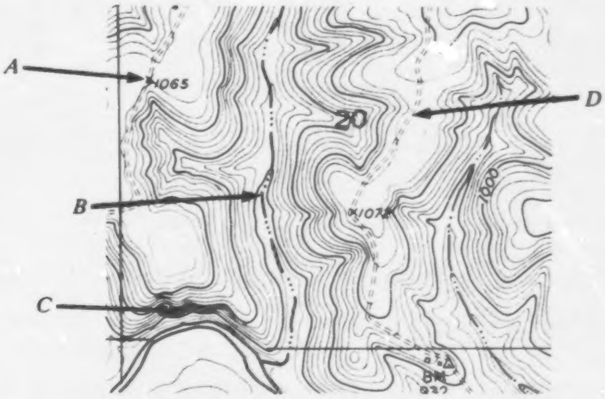
5. The following formula is used to calculate ______________________________.

$$CI = \frac{H - L}{CL - 1}$$

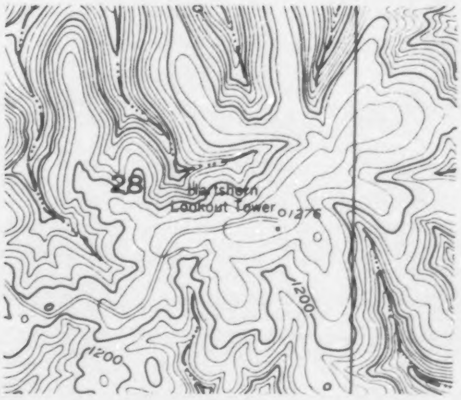
6. On this map draw arrows pointing to 2 different contour lines.



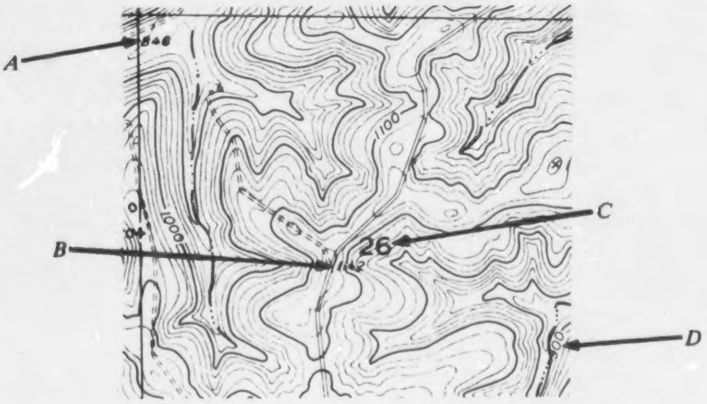
7. Which arrow on this map is pointing to a cliff? ________________



8. On this map draw arrows to 2 stream beds.

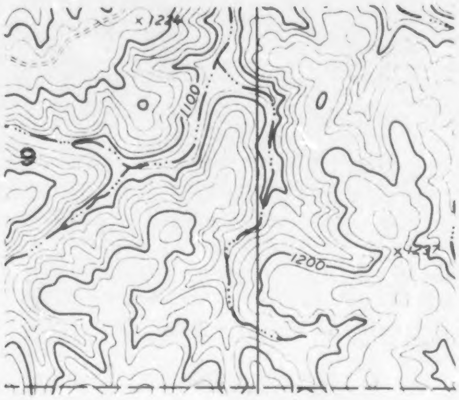


9. On this map which arrow is pointing to a contour elevation notation? ____________



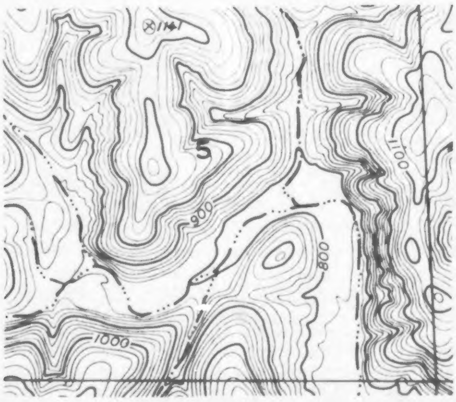
10. A closed contour line which has no contour lines inside it and has a higher elevation than all the surrounding contour lines is a ______________________.

11. Calculate the contour interval for the following topographic map.



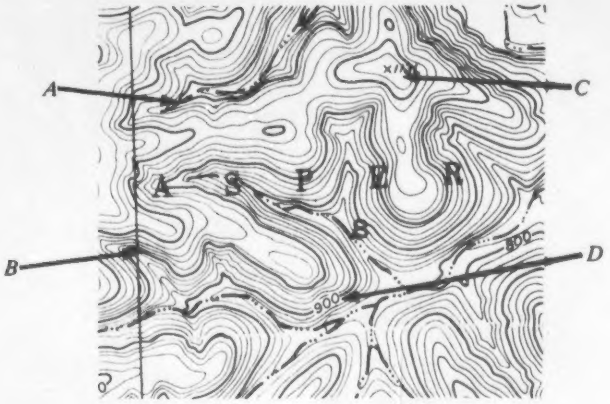
12. A landform represented by closed concentric contour lines, with hachures pointing in the direction of slope, and the centermost line having the lowest elevation of all the surrounding lines is a ______________________.

13. On this map draw arrows pointing to 2 cliffs.

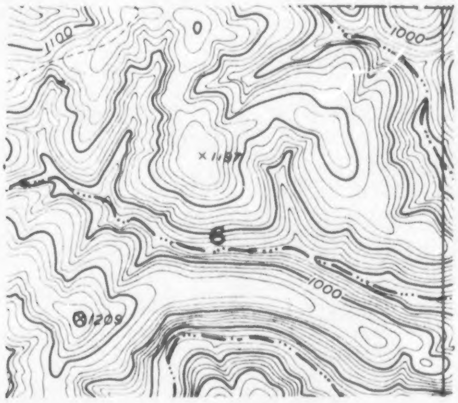


14. A line drawn on a map through all adjacent points having the same elevation above sea level is a/an ______________________________

15. Which arrow on this map is pointing to a hilltop? ________________

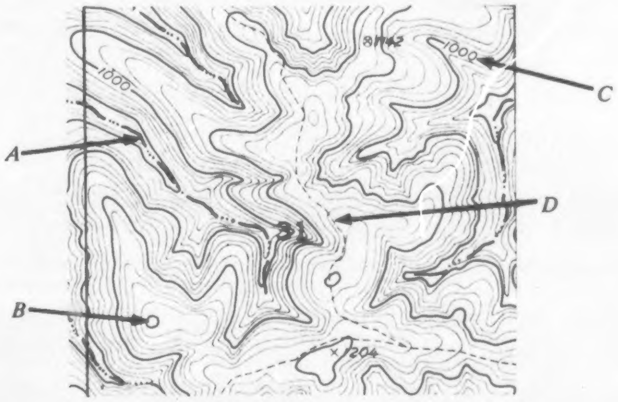


16. On this map draw arrows pointing to 2 contour elevation notations.



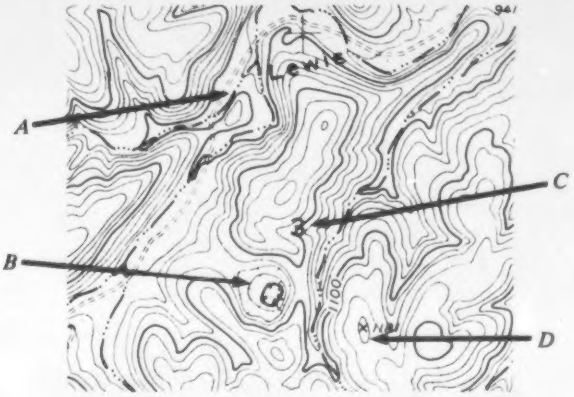
17. What are you calculating if you pick 2 adjacent contour elevation notations, subtract the lowest one from the highest one, and then divide that result by the total contour lines involved minus 1? ________________________________

18. Which arrow on this map is pointing to a stream bed? _______________



19. A group of contour lines representing a large vertical displacement which converge into 1 or very few contour lines in a very small horizontal space is a/an ______________.

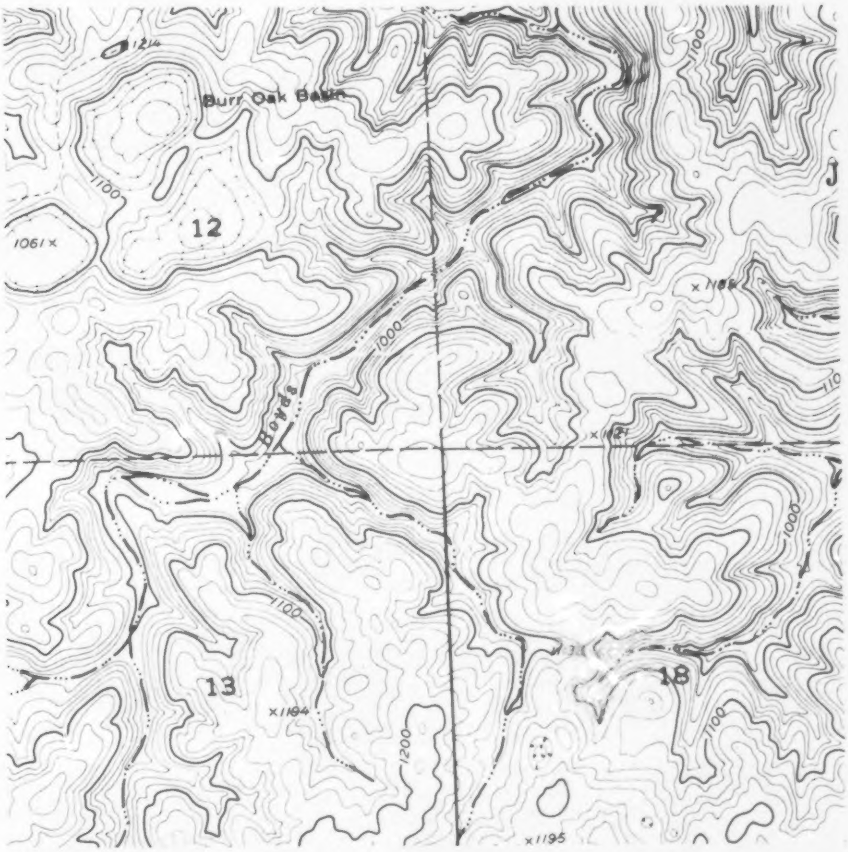
20. Which arrow on this map is pointing to a depression? ______________________



21. A landform represented by contour lines which bend upstream and cross the stream at right angles is a/an ________________________.

22. Using arrows, label on the map 2 of *each* of the following landforms:

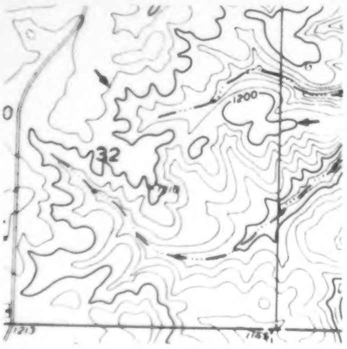
1. Hilltops
2. Cliffs
3. Depressions
4. Stream Beds



Answer Key

Contour Line

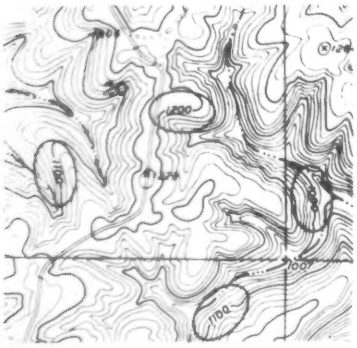
1. *Not all contour lines are marked.*



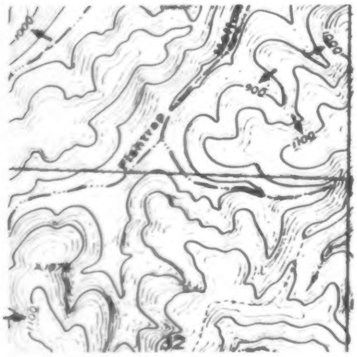
2. C

Contour Elevation Notation

1.



2.

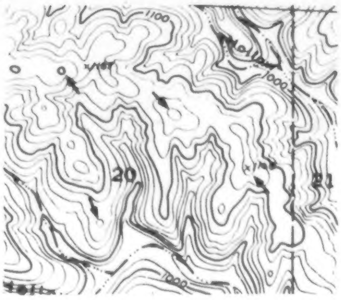


Contour Interval

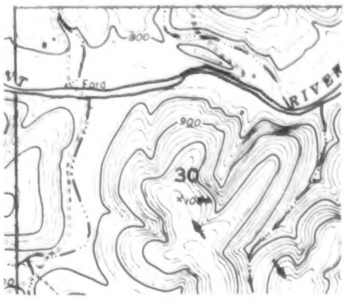
1. 200 ft.
2. 5 ft.
3. 20 ft.
4. 20 ft.

Hilltops

1.

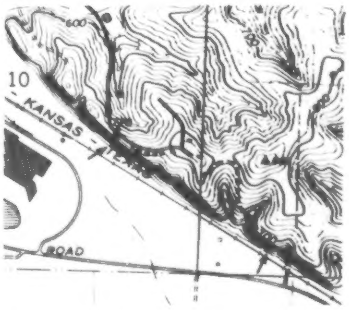


2. *Not all hilltops are marked.*

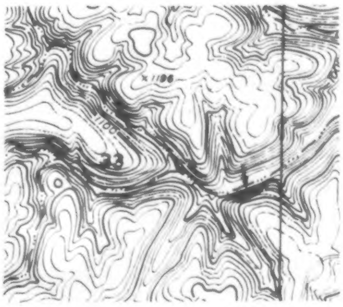


Cliffs

1.

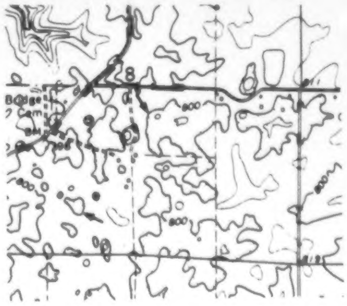


2. *Only example of a cliff is marked.*

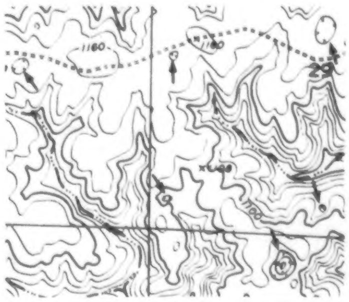


Depressions

1. *Not all depressions are marked.*

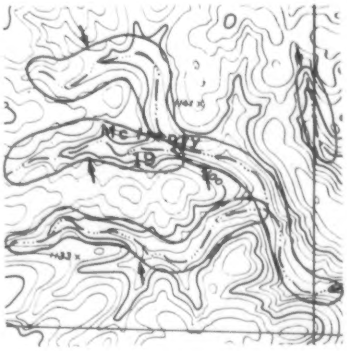


2.

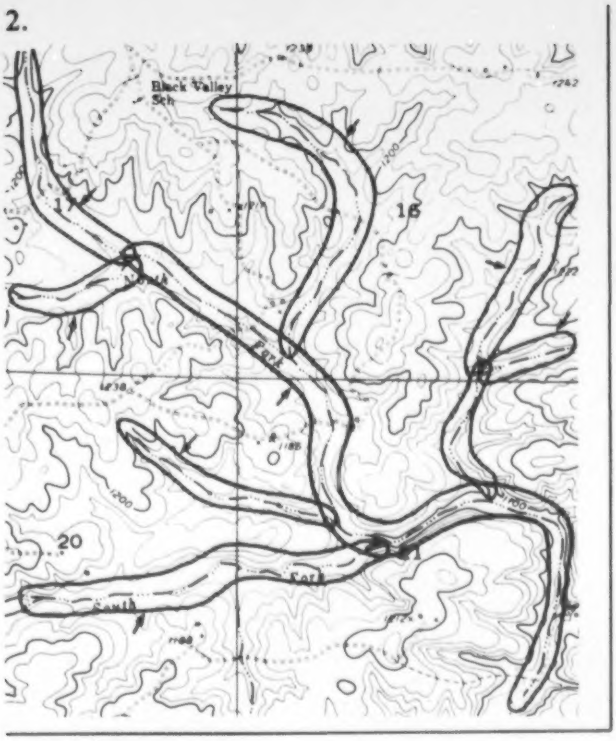


Stream Beds

1.

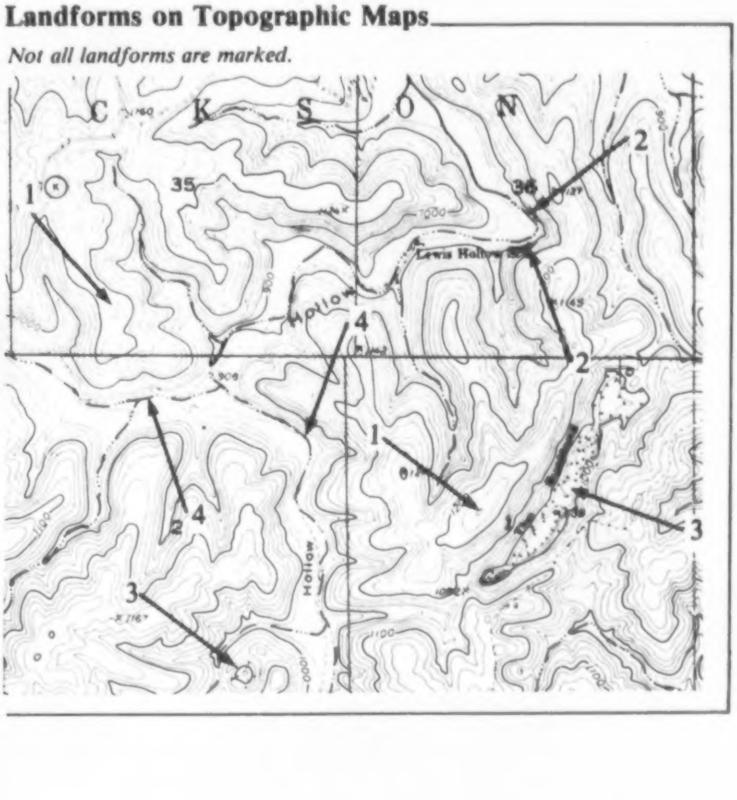


2.



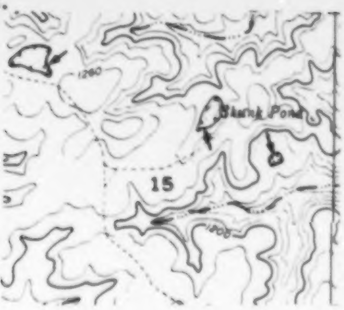
Landforms on Topographic Maps

Not all landforms are marked.

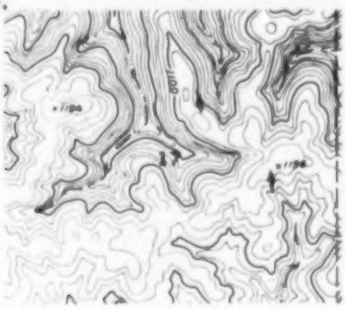


Evaluation Exercise

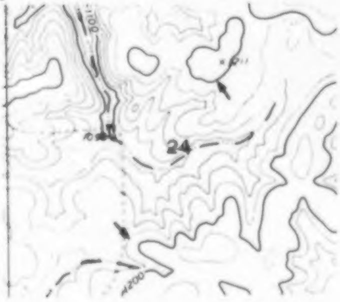
1. B
2.



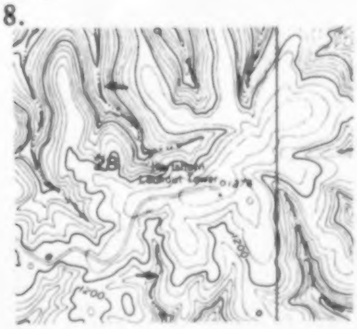
3. elevation notation
4.



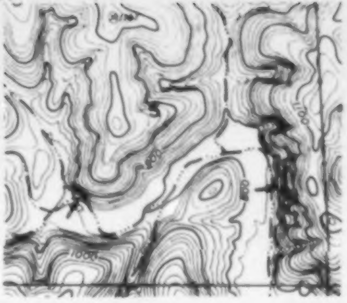
5. contour interval
6.



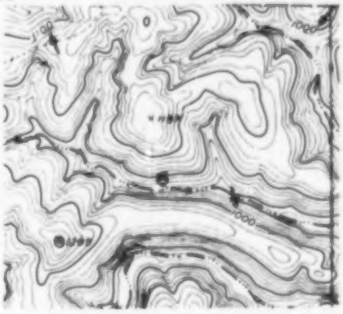
7. C
8.



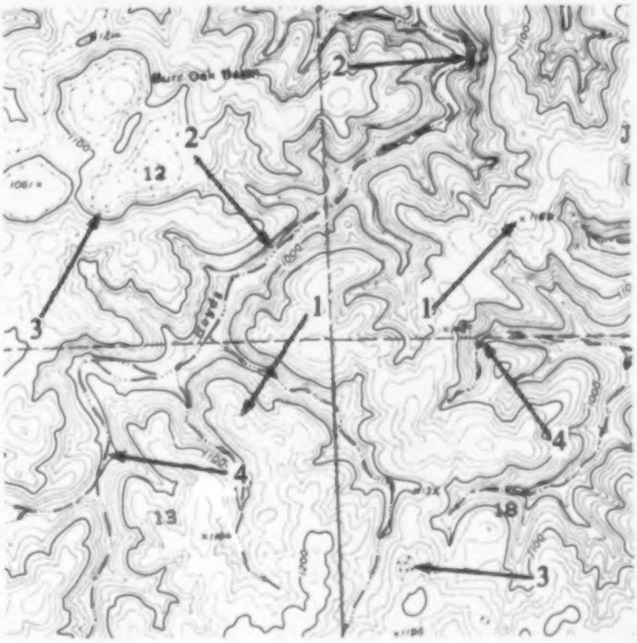
9. D
10. hilltop
11. 20 ft.
12. depression
13.



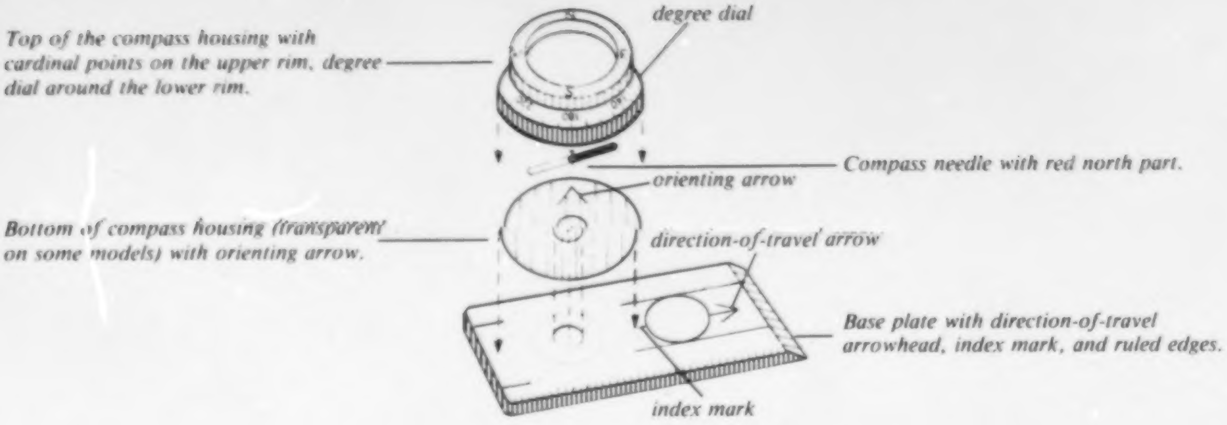
14. contour line
15. C
16.

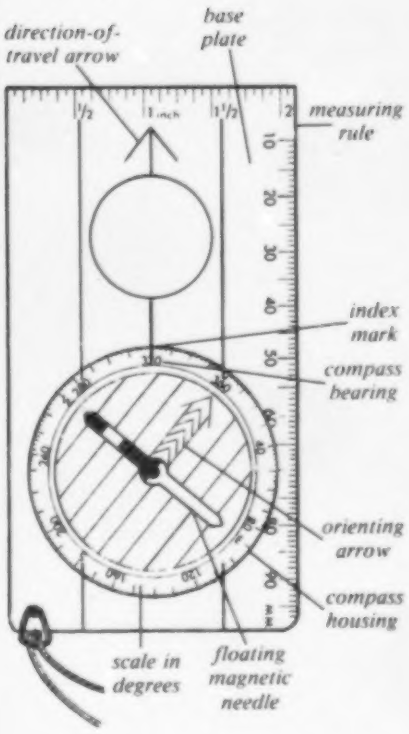


17. contour interval
18. A
19. cliff
20. B
21. stream bed
22.



Appendix 5—The Parts of a Modern Orienteering Compass


degree dial
Top of the compass housing with cardinal points on the upper rim, degree dial around the lower rim.
Compass needle with red north part.
orienting arrow
Bottom of compass housing (transparent on some models) with orienting arrow.
direction-of-travel arrow
Base plate with direction-of-travel arrowhead, index mark, and ruled edges.
index mark



TO TAKE A BEARING ON AN OBJECT

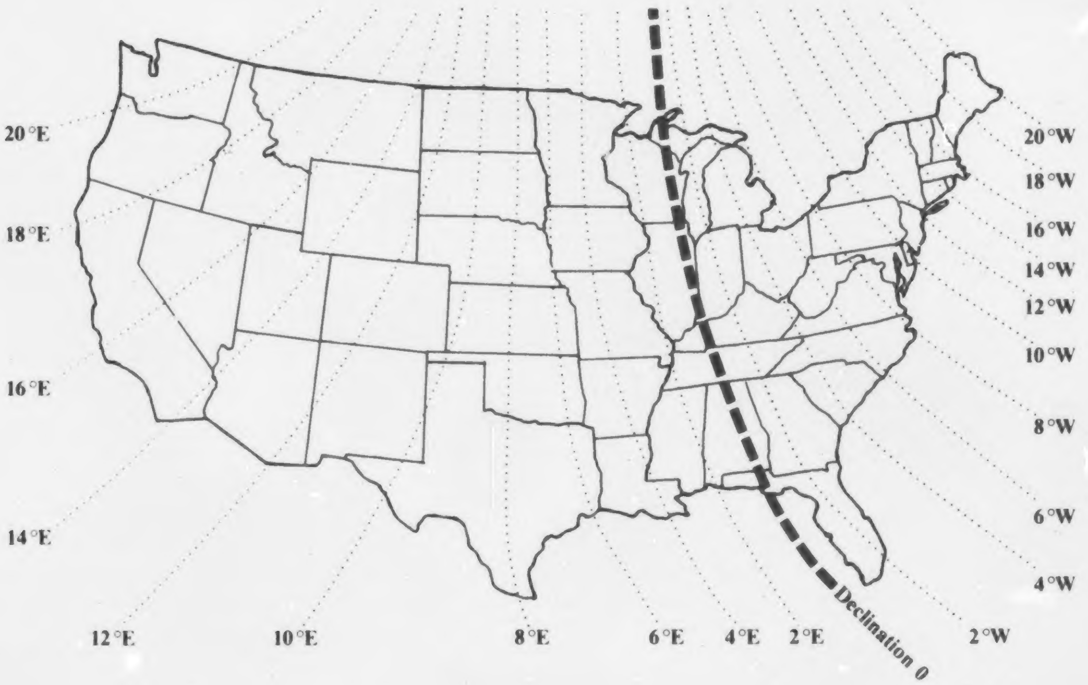
1. Hold the compass pressed tightly to your waist or chest. Make sure it is level. Point your body at the object on which you wish to take a bearing. Adjust your body so the direction-of-travel arrow is pointing at the object.
2. Rotate the compass housing so the orienting arrow matches the magnetic needle (arrowhead under the red end).
3. Read the bearing in degrees where the compass housing intersects the direction-of-travel arrow.
4. Practice taking bearings with your partners and check each other's work.

TO TRAVEL A COMPASS COURSE GIVEN A DESIGNATED BEARING

Example—travel a course of 100°

1. Rotate compass housing until 100° intersects the direction-of-travel arrow.
2. Hold the compass firmly against your chest with the direction-of-travel arrow pointing away from you.
3. Rotate your body until the red magnetic needle lines up with the black orienting arrow. You are now facing 100°.
4. Raise your eyes and fix them on a distant object which is on an imaginary line extending from the direction-of-travel arrow. This is your course.

Appendix 6—Declination Chart of the United States



Data USGS 1980

The above map shows declination of the compass in North America. East of the zero line, declination is "Westerly." West of the zero line, declination is "Easterly."

Appendix 7—Making a Schoolyard Map

Step 1. Determine the scale of your map.
  a. Decide what area will be covered by your map.
  b. Pace off the edges of the area.
  c. Determine how many paces per centimeter will allow the map area to fit on a sheet of paper.

Step 2. Determine what will be included in your map.
  a. Decide what features (buildings, trees, basketball courts, etc.) you want and choose a symbol to represent each. Enter these on the data sheet.
  b. Draw parallel lines on your map sheet to indicate magnetic north.

Step 3. Gather data.
  a. Begin at one corner of the area to be covered by your map.
  b. From your chosen corner take bearings on the objects you wish to include in your map. Pace the distance to each object. Record bearing and distance on the data sheet.
  c. Calculate the map distance using the distances on the data sheet and the scale you selected.

Reminder: When using a compass, keep it away from belt buckles, clipboards, or anything else made of metal.

Step 4. Make the map.
  a. Begin in the corner of your map that corresponds to the corner from which you took your bearings.
  b. Transfer the bearings to the map and measure the proper distance from the corner and draw the proper symbol.
  c. To transfer bearings to map, set compass for bearing given on data sheet. Lay compass on map with base plate touching corner or reference point. Turn entire compass until orienting arrow is lined up with magnetic north line. (Compass base plate should still be against corner and bearing should remain unchanged. Measure the appropriate map distance to put symbol on map.)
  d. Transfer the data from the chart to the map. Measure carefully and recheck bearings with the compass when necessary. Walk from the chosen corner and plot bearings. Measure the appropriate distance in map units and record the symbol on the map.
  e. Add the map legend—title, date, scale, symbols, and direction arrow to complete the map.

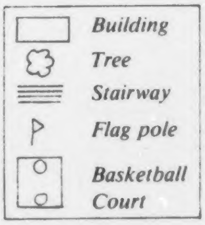
Data Sheet

Scale __1__in. : ______ paces

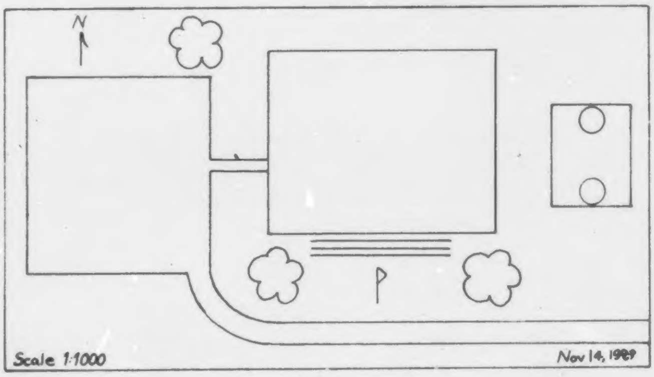
Corner _________

Object	*Symbol*	*Bearings*	*Distance (Paces)*	*Map Distance*

Legend



Schoolyard map



Current River Canoe Trip

See Current River Map

Sample Diary Entry:

Saturday. I left Peter Bay at 8 a.m. The river was flowing at a bearing of ____°. The water sure was cold when I pushed off, must be from all of those springs that flow into it. I spotted a good fishing hole, but the fish just weren't biting this morning. The river was sort of crowded for a Saturday, so I stopped in Bugger Boo Bay and took a hike to Bee Hill. I took a bearing of ____° and traveled ____ miles to get there. The terrain was...

You are going on a two-day wilderness canoe trip down the Current River. You will be putting your canoe in on Saturday at Peter Bay (point "A") and will take your canoe out on Sunday at Goose Lake (point "B").

ON THE MAP

1. Draw the route traveled on the map. Be sure to note the general direction you are traveling. Record in your diary the declination of the map and draw lines of declination on the map. Include why declination is important to consider while traveling this river.
2. Compute the bearing and distance from point to point each time you go for a hike.
3. Maintain a day-by-day diary of the trip. Write in this diary a short statement about what you did each day according to the instructions and the special features of the land. Answer the questions you are asked in the instructions as part of your diary entries. (See sample diary entry.)
4. Assume you can travel 5 miles per hour by canoe and 2 miles per hour by foot.
5. Camp only at existing campsites (shown as "CS").
6. Canoe a maximum of 15 miles per day.
7. Visit at least 2 places other than those you are instructed to visit.
8. As the last entry in your diary, write down the total miles you traveled on the river and the total miles you hiked on the trip.

INSTRUCTIONS

1. Get into the Current River at Peter Bay. Double check to make sure you have all of the supplies you will need for two days. How about equipment? Did you remember your map and compass?
2. Travel downstream in your canoe, being sure to keep track of how many miles you travel. How can you tell from the map that you are going downstream? As you pass Dark Bay, look and see what makes Dark Bay so dark.
3. Your first expedition is to Bee Hill. Pull the canoe into Bugger Boo Bay and figure the distance and bearing. Is there anything important about the height? How high is it? How many roads did you cross to get there? What kind were they? No fair walking down the road!
4. When you get back to the canoe, check the direction you are traveling before putting into the swift water again. The sun is moving quickly on its course. The time is 10:30 a.m. and you are facing downstream. In what general direction is the sun?
5. You're making good time, so stop over at Deer Leap and admire the beauty. Climb to the top and look down on the river. What is the feature of this area? Where did you

beach your canoe to take the hike? Why? At what bearing did you travel? How far was it?

6. It is getting about lunch time. Find a good spot. Keep on the lookout for a campsite but don't forget how far you will have to travel the second day of the trip.

7. Stop at The Nook and climb out far enough to count the number of hilltops. How many do you see?

8. What is the land along the river like for the next two miles? Take time to hike to Worley Rock. How did you hike to get there? Why? What was the distance and bearing?

9. You consider taking a hike to Doniphan, so you figure the bearing, then later decide there are better trips to make.

10. Wave at the people in City Park as you go by. What direction is the river flowing? Is your trip half over yet?

11. Did you sleep well last night? What campground did you choose? Why? How many miles did you travel yesterday? Are you going to make it to Goose Lake before dark?

12. You notice Towles Cemetery on the map and decide it's time for a hike. How far did you hike and at what bearing? While you're at the cemetery, find who has the oldest marker and the largest family buried there. What direction do the fronts of the markers face?

13. Time to get back in the canoe. Did you see Bluff Cottage? Where is it located?

14. Explore Big Island. How far is it across at its widest point? How long is it? Map your explorations.

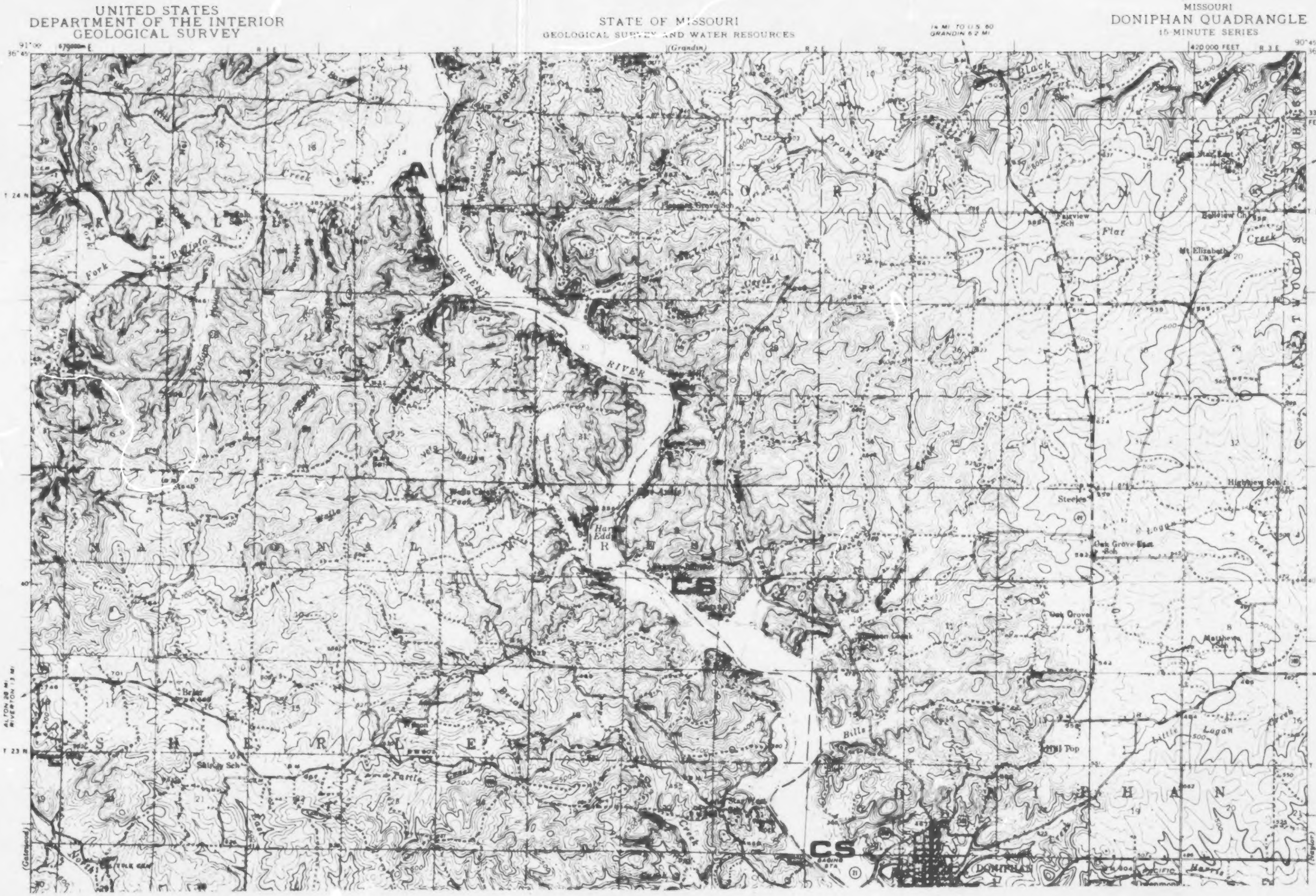
15. The river is picking up speed, so you had better concentrate on canoeing. From what direction does Wells Creek flow into the Current River?

16. You made it. Goose Lake is just around the bend. How far will you have traveled today when you reach Goose Lake? What time is it? What direction is the river flowing? Drag yourself and the canoe out of the water and shake the sand off. Congratulations, you did it!

Practical Exam

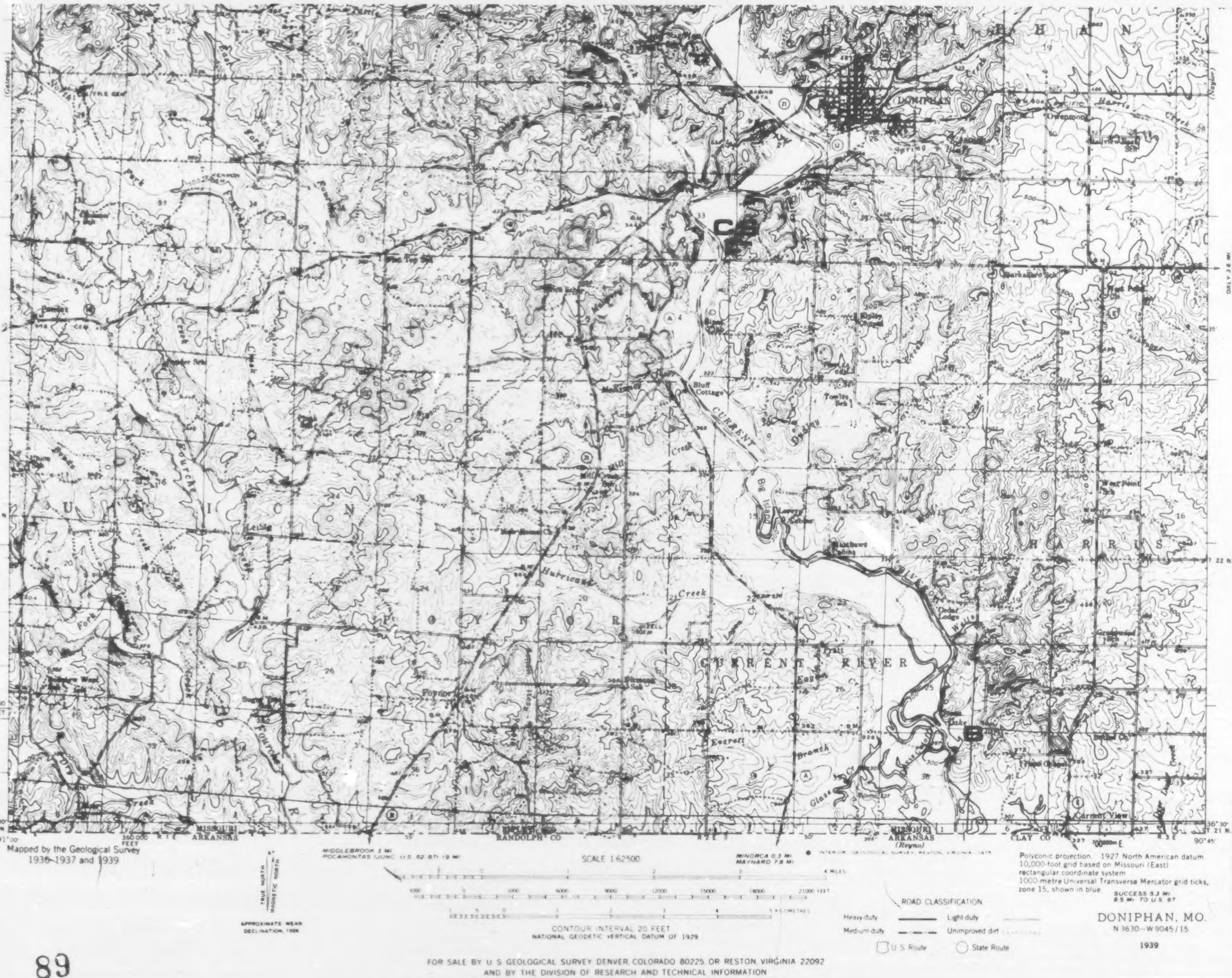
1. To determine if your students can use a map and compass, take them outside and have them follow a course you have set up in the schoolyard or out in the field. They should follow a marked map course using a compass.

2. In the field, give them a topographic map of the area where they are and have them determine their location using bearings taken from objects on the landscape.



Student handout

87



Mapped by the Geological Survey
1936-1937 and 1939

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Polyconic projection. 1927 North American datum
10,000-foot grid based on Missouri (East) rectangular coordinate system
1000-metre Universal Transverse Mercator grid ticks, zone 15, shown in blue

DONIPHAN, MO.
N 3630—W 9045/15

1939

FOR SALE BY U S GEOLOGICAL SURVEY DENVER COLORADO 80225 OR RESTON VIRGINIA 22092
AND BY THE DIVISION OF RESEARCH AND TECHNICAL INFORMATION
MISSOURI DEPARTMENT OF NATURAL RESOURCES, ROLLA, MISSOURI 65401
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Student handout

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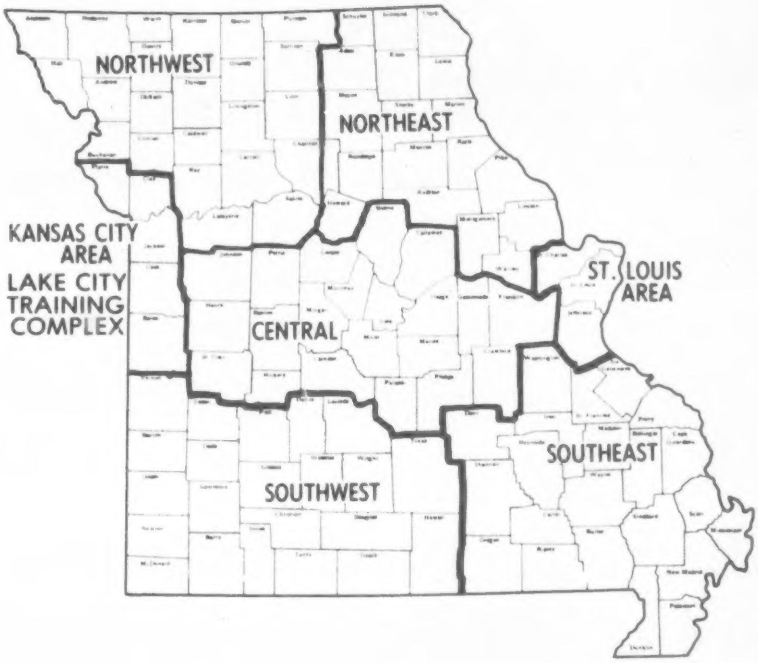
816/453-0546

Lake City Training Center and Range
Lloyd Williams
Kansas City Sub-Office
Brywood Shopping Center
8616 East 63rd Street
Kansas City, MO 64133
816/356-2280

Outdoor Skills Education Specialists and Education Consultants will assist you in obtaining materials and scheduling equipment and films that are available from the Department of Conservation. They also offer workshops to provide training in outdoor skills and conservation education.



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District 14
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Kearney, MO 64060
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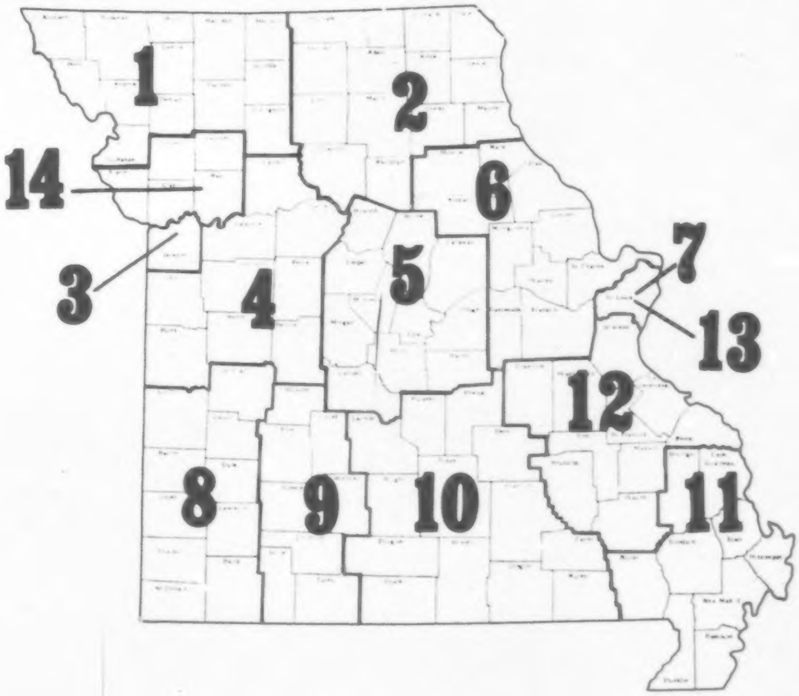

Notes